VOLUME 9 NUMBER 2
SPRING 2021

FOFJ

ISSN-INTERNET: 2197-411X
OCLC-NR.:862804632

THE FUTURE OF FOOD JOURNAL

JOURNAL ON FOOD, AGRICULTURE & SOCIETY

Publisher

VDW VEREINIGUNG DEUTSCHER WISSENSCHAFTLER

UNIKASSEL VERSITÄT | ORGANIC AGRICULTURAL SCIENCES

SFS Sustainable Food Systems & Food Sovereignty

Future of Food: Journal on Food, Agriculture and Society

Volume 9, Number 2
May 2021

Published 31 May 2021

Specialized Partnerships in Sustainable Food Systems and Food Sovereignty, Faculty of Organic Agricultural Sciences, the University of Kassel, Germany and the Federation of German Scientists (VDW)

ISSN Internet	**2197 411X**
OCLC Number	**862804632**
ZDB ID	**27354544**

open access

Address
Future of Food: Journal on Food, Agriculture and Society
Specialized Partnerships in Sustainable Food Systems and Food Sovereignty,
Faculty of Organic Agricultural Sciences,
University of Kassel,
Nordbahnhofstrasse 1a,
D- 37213 Witzenhausen,
Germany.

Telephone: + 49 5542 98 -1621
Fax: + 49 5542 98 -1604

Email: *editorialboard@fofj.org*

Official web page of the journal
www.thefutureoffoodjournal.com

Social Media of the journal
www.facebook.com/futureoffoodjournal

Table of Contents

ISSN-Internet 2197-411x OLCL 862804632

Reviews

Front Cover page -

- Designed by Rami Al Sidawi

Cover page - Photo Credits

- Guillaume Cordel: https://flic.kr/p/2hX6PM7
- Anindita Roy: https://flic.kr/p/X5bEyx
- Rahel Jaskow: https://flic.kr/p/5YuHwj
- Agilemktg1: https://flic.kr/p/Lk5qhg
- Michael Stern: https://flic.kr/p/q7hGJR
- Rabac Liviu: https://flic.kr/p/8nSiNL
- Jon Queen: https://flic.kr/p/pPMGTW

ISSN-Internet 2197-411x OLCL 862804632
UniKassel & VDW, Germany-May 2021

Editorial

In the spring of 2020, our world got turned on its head

Dr. George Horváth, PhD, is a Senior Lecturer and researcher at the Budapest University of Technology and Economics, Faculty of Economics and Social Sciences, Department of Environmental Economics. His research focuses on grassroots initiatives of local communities for sustainable development.

This statement has been thrown around so much we seem to have lost grasp of the severity. We began to adjust to leading a new way of life, unimaginable even months before. We were picking up new knowledge and adopting new skills to cope with the emerging challenges. We even had to learn a Corona-newspeak, including "lockdown" and "essential workers".

The latter is generally understood to be shorthand for those medical professionals who push their human boundaries every day to save patients' lives: doctors, nurses, ambulance staff, and so on. Without wanting to fail to acknowledge the dedication, effort and sacrifices of these genuine heroes, I must add that perhaps there is an entire flood of essential workers, without whom our life could simply not go on: those who produce the food we put on our tables (1).

The restrictions and lockdowns began to be rolled out by governments, so entire sectors of the economy ground to a near halt (2, 3, 4). Quite perilously, this did include parts of the food chain as well (5). Disruptions of varying severity were present in every link of the chain, from production to processing, logistics, distribution and sales. In quick succession, sudden shortages and rapid oversupplies seemed to follow, and end-consumer prices of many products remain elevated to this day.

The past year offered plenty of opportunities to think about how the food that we eat every day comes to be. (After all, there was no shortage of free hours to spend contemplating the major and minor things in life, certainly during a lockdown.) Some - those who had access to them - took to their gardens and allotments to keep themselves busy and healthy (6, 7, 8) in more ways than just keeping active. Growing and making their own food was a new experience

ISSN-Internet 2197-411x OLCL 862804632

UniKassel & VDW, Germany-May 2021

to many (9). Hopefully, an experience that has made them appreciate the efforts of those invisible millions across the planet who make each meal possible. Furthermore, it has also hopefully brought home the message to many about the incredible human efforts and natural resources wasted with each item of food that never makes it to the consumer's plate.

As expected, in the not-so-distant future, things will be normal again. That normal will be undoubtedly different to the pre-pandemic era, and that is quite possibly a good thing too. Perhaps we can hope that consumers will be more conscious about how their food is made: how much labour and natural resources go into each meal that we consume. Perhaps that consciousness shall give rise to a reduction in food unnecessarily wasted. The possibility that reducing food waste shall reduce the exploitative and unsustainable practices that are currently endemic in the food industry. Perhaps, perhaps, perhaps…

The UN's Sustainable Development Goals demand that we cut hunger to zero. Still, good health, decent work, clean energy, responsible consumption and production, and climate action are on the agenda for our foreseeable future (10). During the lockdowns, we have learned many valuable lessons, experts and laypeople alike. Both about the fragility of our standard practices and the benefits of taking another good, hard, honest look at how the industry feeds us. And hopefully, we will be able to commit to changes, both top-down and grassroots actions, which can take us to meet these goals for sustainable development finally.

If we finally do, it will not be a minute too soon.

References:

1. Ximena Bustillo and Ryan Mccrimmon. Who is 'essential'? Food and farm workers left in limbo in vaccine priorities. https://www.politico.com/news/2021/01/17/covid-vaccine-food-farm-workers-459845

2. Schmidhuber J. and Qiao B. Comparing crises: Great Lockdown versus Great Recession. https://doi.org/10.4060/ca8833en

3. Michael König and Adalbert Winkler. COVID-19: Lockdowns, Fatality Rates and GDP Growth. Evidence for the First Three Quarters of 2020. Intereconomics volume 56, pages32–39(2021) https://link.springer.com/article/10.1007/s10272-021-0948-y

4. Francis J Greene, Alessandro Rosiello. A commentary on the impacts of 'Great Lockdown' and its aftermath on scaling firms: What are the implications for entrepreneurial research? https://doi.org/10.1177/0266242620961912

5. Serpil Aday, Mehmet Seckin Aday. Impact of COVID-19 on the food supply chain. Food Quality and Safety, Volume 4, Issue 4, December 2020, Pages 167–180, https://doi.org/10.1093/fqsafe/fyaa024

6. Annalisa Theodorou, Angelo Panno, Giuseppe Carrus, Giuseppe Alessio Carbone, Chiara Massullo, Claudio Imperatori. Stay home, stay safe, stay green: The role of gardening activities on mental health during the Covid-19 home confinement. Urban Forestry & Urban Greening Volume 61, June 2021, 127091 https://doi.org/10.1016/j.ufug.2021.127091

7. Janie Corley, Judith A. Okely, Adele M. Taylor, Danielle Page, Miles Welstead, Barbora Skarabela, Paul Redmond, Simon R. Cox, Tom C. Russ. Home garden use during COVID-19: Associations with physical and mental wellbeing in older adults. Journal of Environmental Psychology Volume 73, February 2021, 101545 https://doi.org/10.1016/j.jenvp.2020.101545

8. A. Sachs Naomi. Access to Nature Has Always Been Important; With COVID-19, It Is Essential. https://doi.org/10.1177/1937586720949792

9. Jane Perrone. How coronavirus changed gardening forever. https://www.ft.com/content/c3abc0bb-7ade-4ae1-8d2b-d3fa6be53416

10. https://sdgs.un.org/goals

ISSN-Internet 2197-411x OLCL 862804632

Research Paper

Future of Food: Journal on Food, Agriculture and Society
9 (2) May 2021

Dependency and economic benefits of the use of wild food plants among tribal communities in Malai Madeshawara Hills wildlife sanctuary, Southern India

Harisha R.P.[1*], Siddappa Setty R.[1], Ravikanth G.[2]

[1]Centre for Environment and Development, Ashoka Trust for Research in Ecology and the Environment, Royal Enclave, Srirampura, Jakkur Post, Bengaluru- 560 064, India
[2]Centre for Biodiversity and Conservation, Ashoka Trust for Research in Ecology and the Environment, Royal Enclave, Srirampura, Jakkur Post, Bengaluru- 560 064, India

* Corresponding author: hari@atree.org, Phone: 091-080-23635555

Data of the article

First received : 26 February 2020 | Last revision received : 22 September 2020
Accepted : 07 November 2020 | Published online : 31 January 2021
DOI : 10.17170/kobra-202011192211

Keywords

Wild food plants, indigenous community, dependency, economic benefits

Wild food plant resources and their indigenous knowledge of use are in danger of being lost in areas where rapid environmental and cultural transformations have led to changes in eating habits and practices. The study assesses the dependency and economic value of wild food plant use among forest-dwelling communities. Community perceptions were used to assess the usage patterns among the two communities. The data was collected through a combination of semi-structured interviews, household questionnaire surveys, and focus group discussions in eight villages. Wild food plants are of vital importance to local communities in terms of food security, dietary diversity, and household economy. Local communities use wild plant species as vegetables, fruits, beverages, in traditional therapeutic practices, and as a symbol of ethnic identity. The taxonomical distribution and diversity of 124 species belonging to 57 families and 91 genera were assessed. The cash value of wild food plants to a household ranged from ₹ 15 to 20 per cent of the annual income. These plants are a reliable safety net for many households and play a vital role in the livelihoods of the local people. The study highlights the dependency and livelihood importance of these plants.

1. Introduction

Wild food plants (WFPs) naturally grow in forests, farmlands, fallow land, roadside, and near bodies of water and streams without human care and are used by local people as sources of food. A large number of people around the world depend on these WFPs, as these not only contribute to food and medicine but also as vital sources of micronutrients. The WFPs are also part of the socio-cultural practices of indigenous communities (Grivetti & Ogle, 2000; Agea *et al.,* 2011; FAO, 2017). Despite the primary reliance of most resource-poor villagers on staple crop plants, the tradition of eating WFPs continues to the present day. In recent years there is a global interest in documenting ethnobotanical information on neglected wild edible food sources.

Over the centuries, people have relied on WFPs resources for their subsistence as they are an efficient and cheap source of several vital micronutrients (Salvi & Katewa, 2016). The dependency on WFPs for food,

nutrients, and therapeutic use exists across the globe (Shumsky *et al.,* 2014; Raghavendra *et al.,* 2017). In tropical Asia and Sub-Saharan Africa, a large number of people are dependent on WFPs as their source of food. The WFPs serve as a "safety net", especially during drought and since these WFPs are quite hardy, that can adapt to local environmental change and bridge the hunger gap (Tebkew *et al.,* 2014; Shumsky *et al.,* 2014; Joshi *et al.,* 2015; Thakur *et al.,* 2017;). Over a thousand WFPs exist in India, and more than 60 % of rural people use these WFPs as their regular food (Rathore, 2009). Despite India being rich in WFPs resources as well as indigenous knowledge of use, their values are not accounted for in any of the economic analyses of natural resources (Bharucha & Pretty, 2010; Raghavendra *et al.,* 2017). These plant resources and their indigenous use are in danger of being lost in areas where environmental and cultural transformations have led to changes in feeding practices (Raghavendra *et al.,* 2017). Further, the degree of WFPs use and its significance is not fully understood (Puri *et al.,* 2015; Sansanelli *et al.,* 2017). The WFPs are also absent from regional and national food balance sheets that guide policies on aid, trade, and the announcement of food crises (Bharucha and Pretty, 2010; Raghavendra *et al.,* 2017).

A forest-dependent community's livelihood is characterized by the relative contribution of each livelihood activity in the form of monetary or non-monetary value. A monetary contribution to household livelihood comes from formal cash income either through local daily wages, government grants, pensions, livestock, and collection of Non-Timber Forest Produce (NTFPs) (Shaanaker *et al.,* 2004; Puri *et al.,* 2015). Many studies have revealed that non-farm activities account for more than 70% of the total livelihood of households in India (Raghavendra *et al.,* 2017). Historically, subsistence farming, collection of WFPs for self-consumption, and other forest resources used in day- to- day needs constitute non-monetary benefits. The contribution of non-monetary benefits to the total household's income is critically important (Laucena *et al.,* 2007; Ojelel & Kakudidi, 2015;). A community's traditional use of WFPs is part of living links with the land and the plants of the region (Bhatia *et al.,* 2018).

For instance, Philips and Gentry (1993) developed a use-value index, and later, Pieroni (2001), developed a cultural food significance index. Gracia et al. (2006) developed a method to value plant species based on their economical and practical characteristics.

The contribution of WFPs to rural household income is significant and plays a vital role in rural livelihoods in developing countries (Joshi *et al.,* 2015). Yet, the economic values of WFPs have not been assessed at the state or national or international level (Shumsky *et al.,* 2014). Many attempts were made to quantify the economic benefits of WFPs (Bharucha & Prety, 2010). Still, few studies have supplemented the economic valuation of WFPs with presumptions of complexity in the quantitative assessment. Most of the data available has been obtained from case studies on individual local communities or community groups, which do not have authenticity in many cases (Singh *et al.,* 2016). Further, most of the plants collected are used for consumption through sharing or bartering (Geng *et al.,* 2016). The economic value of WFPs consumption in forested communities is thus poorly understood (Agea *et al.,* 2011; Gracia *et al.,* 2015).

In the Malai Madeshwara Hills Wildlife Sanctuary (MM Hills), both the Soliga and Beda Gampana communities, locally known as Lingayat, depend on WFPs resources. WFPs have been a part of their food security, providing cultural and social identity, as well as providing economic supplement for many generations (Kothari *et al.,* 2012; Harisha *et al.,* 2015). However, WFPs are ignored in economic and livelihood valuation, and there is a considerable gap in understanding the dependency on WFPs, which plays a vital role in the local people's diet. There is no information available regarding the systematic knowledge collection process and economic valuations that remain absent in the policy framework in the study area.

It is, therefore, important to understand the scope of dependency on WFPs and their economic benefits as dietary alternatives for future foods. However, agricultural yields have failed to satisfy the need for the daily diet as the population is increasing geometrically. To meet this challenge, increasing the use of WFPs in the diet becomes crucial. The importance of the evaluation of the dependency and the economic value of lesser-known WFPs is crucial. It has been realized to a greater extent by the scientific world in recent years. The present study used both qualitative and quantitative information to understand the dependency and economic benefits of WFPs to rural households. The

ISSN-Internet 2197-411x OLCL 862804632
UniKassel & VDW, Germany-May 2021

objectives of the study were: (1) to assess the dependency on WFPs and (2) to assess the economic benefits of WFPs for local communities.

2. Material and methods

2.1. Study site

The study was conducted in MM Hills, located in South India, between latitude 12˚ 13' and 11˚ 55' N and 77˚ 30' and 77˚ 47'E (Figure 1). It falls in the southern tropical dry zone topography and mountainous north-south trending hill ranges of the Eastern Ghats. The sanctuary covers an area of 906.2 km² and has an undulating terrain and mosaic habitat. The scenic hills and valleys are covered with extensive forests and a chain of continuous mountain peaks with elevation ranging from 600-1380 m.

The climate of MM Hills is quite moderate throughout the year with hot summers and cold winters. The mean annual temperature in the study area is 35.3˚C and varies between 24˚C in winter to 42˚C in summer (Indian Meteorological Data, 2016). It receives rain from the southwest monsoon between May-August and from the northeast monsoon between September-December with a pronounced dry period between January and March. There is considerable variation in rainfall with topography, and the average annual rainfall is 1048mm. However, most of the rain is derived from the northeast monsoon during September-November.

The forest abounds with a large variety of medicinal herbs used by local people in traditional healthcare, cultural, and religious systems. However, the forests are subjected to much anthropogenic activity, including agriculture, pilgrimage, quarrying, minor forest produce, and fuelwood and other development activities (Shaanker *et al.,* 2004). Despite tremendous anthropogenic pressure, the area is rich in biodiversity with 800 species of higher plants (Champion & Seth, 1968). It has different forest types such as dry deciduous (64.34%), scrub woodland (20.50%), and scattered patches of moist deciduous and riparian forest (2.47%) (Champion & Seth, 1968).

There are 16 settlements (villages) scattered within this sanctuary, with another 15 villages spread around its periphery. The local communities depend

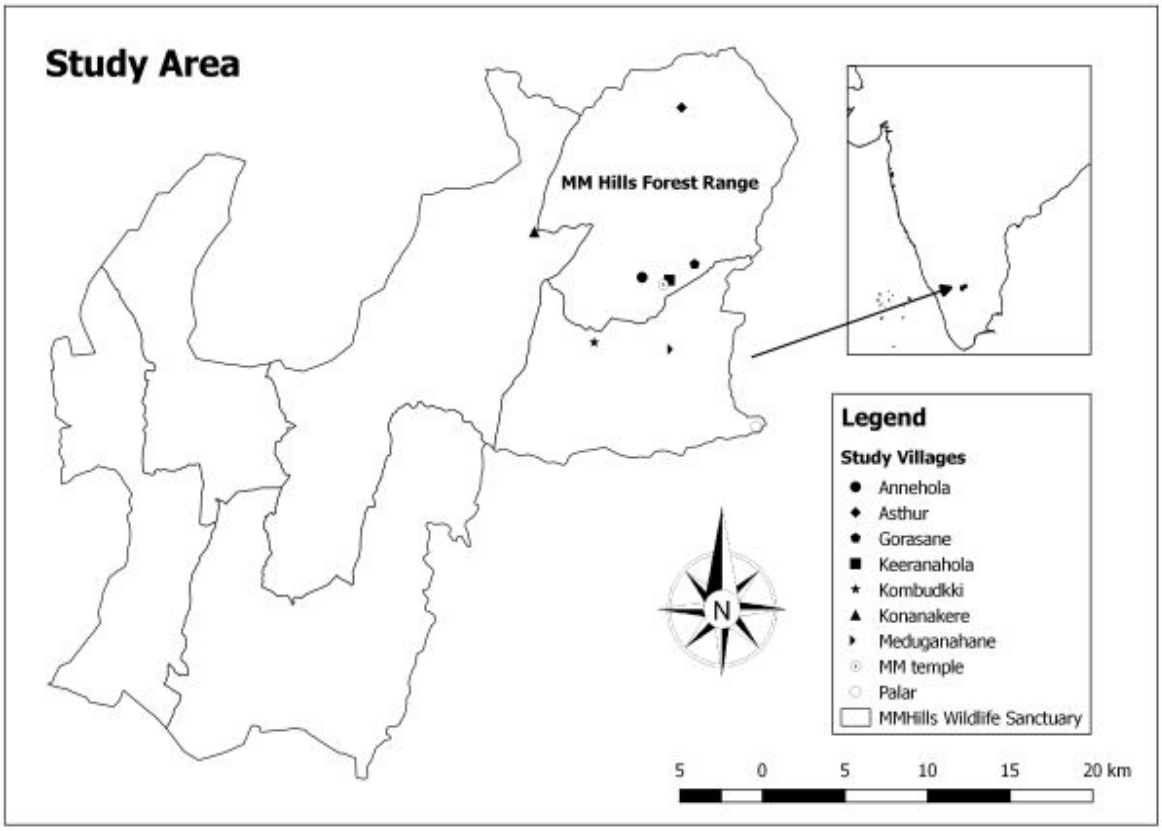


Figure 1. Study area and village locations

on the forest for NTFP and fuelwood collection and for grazing their livestock. They earn their livelihood through agriculture, the sale of NTFP, basket weaving, or through wages working as migratory labourers in stone quarrying or coffee estates and cities (Harisha *et al.,* 2013; Shaanker *et al.,* 2004). About eight villages constitute a homogenous community called Soligas, whereas 23 villages are heterogeneous communities. The Soligas and Beda Gampana are the major communities living in these villages (Table 1).

2.2. Study methods

For the study, eight villages were selected based on the community composition, distance from the town and, location in the forest. Two villages are located at the forest's edge, and the rest are located in the core of the forest. Five villages are located close to town and the main road. Three villages are located in remote forest areas. In four villages both the Soliga and Beda Gampana communities were present, whereas the other four villages only the Soliga community resides. These two indigenous communities have been living in MM Hills for centuries and use common habitat and bioresources. Though they have similar cultural, social, and economic status, they differ in their dietary practices. While the Soligas consume a wide range of both plant and animal-based diet, Beda Gampanas consume an only plant-based diet. All the villages have historically been using WFPs as food, medicine, and as part of their cultural practice. The relevant qualitative and quantitative data was collected from January 2015 to March 2016 through household surveys, key informant interviews, market surveys, and focused group discussions. Prior informed consent (PIC) was taken from the participants for the study with the intent of ensuring welfare, equitable sharing of benefits (monetary and non-monetary), and protection of traditional knowledge. After obtaining the consent from the knowledge holders that the knowledge will be public domain through publication, the data on this study was processed for publication.

Table 1. Socio-economic profile of Soliga and Beda Gampana

Factors	Soliga	Beda Gampana
Family size	4.42 ±2.04	4.60±2.03
Landholding	1.48±1.19	1.67±1.25
Clan system	3 distinct groups (5 clans, 7 clans, and 12 clans)	Only one group (5 clans)
Number of villages (Haadi) where the community is living (distribution)	143 villages in 5 districts	128 villages in 2 districts
Present a diet system	Vegetarian and non-vegetarian	Strictly vegetarian
State reservation category of the community	Scheduled Tribes (ST)	Other Backward Classes (OBC)
Food schemes are available from State Govt.	PDS + special nutritional package (100% free) for every household.	PDS only for Below Poverty Line (BPL) households.
Traditional occupation	Hunter-gatherer now settled in villages and farming	Hunter-gatherer turned priest and farming
Average income/capita/year	₹ 26041.00	₹ 26527.00
Source of income	Migration (69%), Farming (21%), Local labour (3%), NTFPs collection (7%)	Migration (58%), Farming (28%), Local labour (5%), NTFPs collection (9%)
Economic status	>80% of households are below the poverty line	<50% of households are -below the poverty line
Number of WFPs known	112	108
Infant and child mortality rate	Less	More

ISSN-Internet 2197-411x OLCL 862804632

2.2.1. Exploration with villagers and individual interviews

At the beginning of the study, to collect and document the WFPs, three explorations were conducted in different seasons (summer, rainy, and winter). The rains start in May and continue until December. The winter occurs from November to February and summer from March to May. The transect walk was planned for about 8 kilometres covering major land-use types and WFPs-rich areas, which was decided by the community. The first exploration was conducted in Gorasane village, close to the temple town located in the middle of the forest that represents both communities. Similarly, Palar was selected as another sample village and is located on the edge of the forest, and only the Soliga community lives here. The participants were from both communities, and the average participants for each walk were 15 people, in ages ranging from 30 to 55 years with four women and the rest men.

The walk commonly included farmland, fallow land, forest land, bodies of water, and roadside. While walking in the transect, sample plants were documented and collected for further reference and as herbarium depository. Also, ethnographic information was recorded from the participants on the collected plants while walking through the transect. The collection methods, processing recipe, economic and therapeutic values were also discussed during the walk. At the end of each exploration walk, the plant materials collected were authenticated by knowledgeable older adults.

The preliminary identification and documentation (using scientific and vernacular names) were made by examining fresh plants procured by the villager. The plant material was identified with the help of local flora (Gamble, 1957; Saldhana & Nicholson, 1976). The collected voucher specimens were deposited in the herbarium at the Community-based Conservation Centre (CCC) at MM Hills managed by ATREE. A clear expression of consent was obtained before each interview. Throughout this field study, ethical guidelines, as stated by the International Society of Ethnobiology (ISE, 2013), were adopted.

2.2.2. Household survey

Semi-structured interviews (Newing *et al.,* 2011) were conducted for 184 households from eight villages. Interviews were conducted for 23 households, which was 10% of the total households of the village. The households were selected for the interview by considering the family size (number of people in the house), occupation (farming, daily wage, and others), and literacy level (no schooling, primary school, middle school, high school, and college) to draw reliable information. Women were part of the farming activities in all the families of both communities.

The household survey was conducted from August to November 2015, and the same households were revisited from February to May 2016 to fill the gaps, cross-check, and validate the information on WFP's use and socioeconomic profile. During the interviews, vernacular names and photographs of the wild plants were used along with the questionnaire to avoid confusion. The interviews were focused on the WFPs known, frequency of use, reasons for use, and their economic and dietary values. A list of WFPs known, collected, and used from the farms and forests was prepared separately. The respondents' households were also asked about the crops under cultivation, WFPs collection methods, economic and therapeutic value, and preparation methods (recipe). The household interviews were of 1-3 hours duration, and the households were revisited for reliability.

2.2.3. Focus group discussion

Focus Group Discussions (FGD) were conducted twice a year for 2015 and 2016 in all eight villages. The questions were based on the household interviews and exploration to capture and fill in missing information, and to validate the information during the exploration of the household interviews. FGDs provided an opportunity for the local people to take part in the research and share their experiences. Thirty- two FGDs were conducted in the eight study villages, of which four FGDs were conducted in each village at six-month intervals. The average number of participants in each FGD was ranged from 16 to 28 people. In each of the FGDs, more than 30% of total participants were women, and 40% of the total participants were above 60 years old. Equal numbers of participants were present from both the communities in all the FGDs. All

the participants actively participated and shared their knowledge.

Discussions were held with knowledgeable men and women aged between 18 to 80 years in all the eight villages. During the meetings, shortlisted questions were asked, WFPs photographs were shown to the respondents to assess their perception on the livelihood implications of WFPs, and their responses were recorded in detail regarding the dietary values of the WFPs, medicinal values, and economic benefits. These meetings usually took 3-5 hours and were conducted separately.

2.2.4. Market survey

During the study, a market survey was conducted in major seasons like summer, rainy, and winter to capture the seasonal change in the variety of plants sold and to record information on its market price. Two local vegetable markets, one in Kolathur (average 30 kilometres away from the study villages) and another at Hannur (average 40 kilometres away from the study villages) were visited. Semi-structured interviews were conducted with the vendors, and the prices and varieties of vegetables sold, source of procuring, and income were assessed.

2.2.5. Key informant interviews

Eight key informants (one person from each village) were identified, and interviews were conducted to cross-check the information collected during the household survey, focus group discussions, and market survey. The key informants known to be the most knowledgeable were older adults, who had lived and worked in this area and had been using WFPs for a long time. They were frequently consulted during the study to clarify any doubts or confusion regarding the parts used availability of WFPs in the study area, nutritional importance, therapeutic food values, and economic benefit to the households.

2.2.6. Data analysis

The data collected during the exploration and household surveys were used to assess the number of species collected, the source, the season of collection, parts collected, and frequency of use. Descriptive analysis was used to categorize the WFPs in terms of the plant family, genus, plant part used, life form, use category, and available season. The percentage of species used in the forest and farmlands were calculated. Further, the percentage of different parts used for food was calculated. The Use Index (UI) was calculated for each species using the equation UI=Us/N, where Us is the number of households which uses a particular species and N is the total number of households interviewed in the research area (Laucena *et al.,* 2007; Phillips & Gentry, 1993).

The key informant interview data were used to validate the quantitative and qualitative information collected from the FGD and the market survey. The household data was also used to develop a socioeconomic profile and to calculate the economic value of each species.
Economic values: The frequency of WFPs collection, time spent, and prevailing daily wages were used to estimate the economic value of all the 124 plant species. The following formula is taken from Gracia et al. (2006) with relevant modification:

EVe=Fee*Tee *Pee

Where EVe is the economic value of the WFPs, Fee is the mean number of days collected and brought to any household, Tee is the mean time spent on the collection of WFPs species, and Pee is the price of the WFPs species. The Spearman correlation coefficient analysis was employed to compare WFPI and other income sources (AGRII, MIGRI, MFPI, LANH, and LANU). Further, the Wilcoxon rank test, a non-parametric test, is used to assess income sources and their relation with WFPI.

Relative importance index: Based on use categories and relative frequency of citation, relative importance index (RII) values were calculated for each species by adopting the formula from Santayana (2003a):

RII=Relative frequency of citation (RFC) + Relative number of use categories (RNU)/2

The RII index theoretically varies from 0 (when nobody mentions any use of the plant) to 1 (when the plant is most frequently mentioned as useful in the number of use categories).

Later, the Spearman correlation coefficient was used

ISSN-Internet 2197-411x OLCL 862804632

to compare the various indices since all the variables considered were not distributed normally. Further, the Wilcoxon rank test, a non-parametric test, was used to assess the significance. The quantitative data analysis was carried out using a spreadsheet and R (version 3.3.1) (R Core Development Team, 2013).

4. Results

4.1. Dependency on WFPs resource

The local communities in the MM Hills use 124 plants for food, 68 species for medicine, 32 species for agriculture and household tools, 14 species for cash income, and 26 species for spiritual and cultural activities. Among the 124 WFPs species listed, 103 species (83.7%) are common across forest and land use types. There are 91 (73.9%) and 96 (78.5%) distributed within the forest and farmland, respectively (Table 2).

The leafy vegetables listed by the local communities were used regularly over generations, and frequent citation indicates their vital importance in the household diet. The results revealed that the source of WFPs from diverse habitats ranging from farmland, wetland, fallow land, and from different forest types starting from scrub at a lower elevation, dry deciduous, riparian at middle elevation, and moist deciduous at a higher elevation.

4.1.1. WFPs diversity

The WFPs collected during the study were distributed among 57 families, 91 genus, and 124 species. The data revealed that the Amaranthaceae family had the highest number of WFPs species- 11 (8.9%), followed by Solanaceae - 7 species (5.6%), and Anacardiaceae - 5 (4.05%). The highest number of WFPs species 6 (4.8%) belonged to the *Solanum* genus, followed by *Amaranthus*- 5 species (4.06%), *Ziziphus* - 4(3.2%), and *Grewia*- 4 (3.2%) (Figure 2).

Herbaceous species belonging to the genus Amaranthus, *Digera, Cassia, Cleome*, and *Cocculus* were abundant in the farmland. Tree genus such as *Grewia, Syzygium, Phyllanthus,* and *Diospyros* species were common and more abundant in the forest habitat. Similarly, climber species belonging to the genus *Dioscorea, Asparagus, Decalepis,* and *Ceropegia* were common and more abundant in the forest than in the farmland. WFPs species such as *Amaranthus viridis L., Solanum erianthum Don.,* and *Anredera vesicaria* (Lam.) Gaertn. fil. were rarely found in the wild and instead, cultivated in the backyard.

4.1.2. Seasonal dependency

The WFPs displayed distinct seasonal patterns. About 81 species were available and collected during the rainy season (May to December). The highest number of leafy vegetables and fruits were collected during the rainy season. Most tubers were available in summer

Table 2. Foraging of WFPs in the study area

Forest & Land Use	No. of WFPs Species Available	% of WFPs Species (to total number of WFPs species documented; N=124)
Forest	91	73.9
Scrub	55	44.7
Dry deciduous	68	55.2
Riparian	23	18.6
Moist deciduous	43	34.9
Non-forest	96	78.5
Farmland	78	63.4
Fallow land	36	29.2
Home garden	18	14.6
Wetland	6	4.8

(February to April), and shoots and flowers were collected in winter (November to January) (Figure 3).

Similarly, vegetables collected from herbs were mainly available (42.3%) in June and July, i.e., the rainy

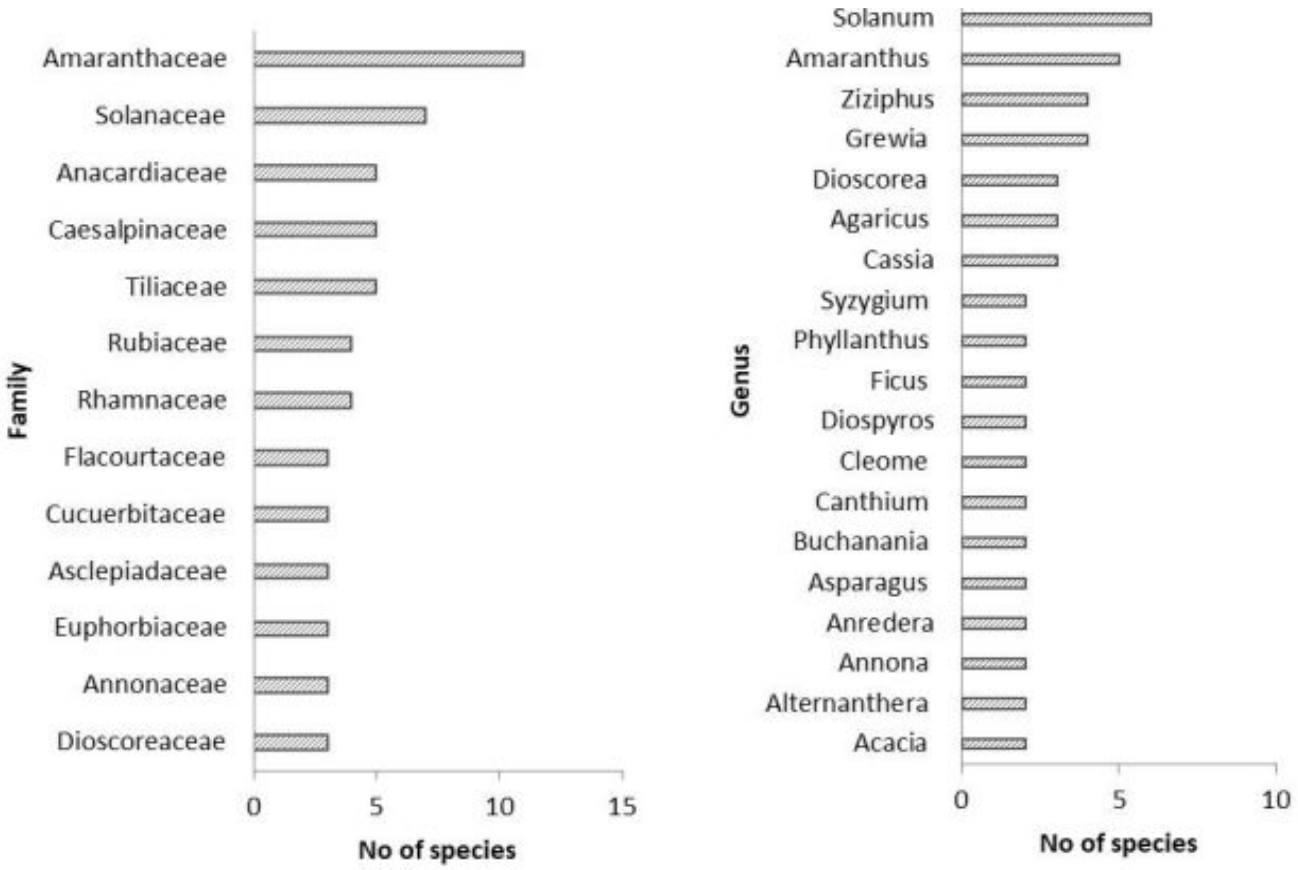


Figure 2. Major botanical families and genus with WFPs species

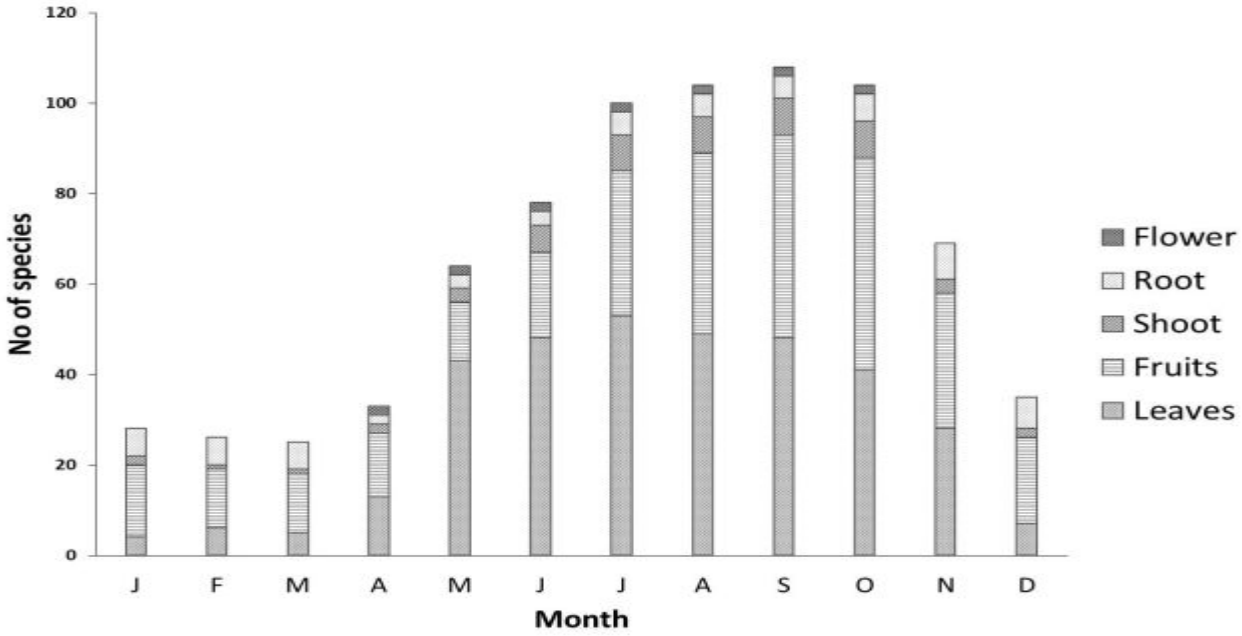


Figure 3. Seasonal forage calendar of WFPs

ISSN-Internet 2197-411x OLCL 862804632

season. Tubers collected from climbers were available highest (36%) in February and March, i.e., in the summer. Fruits and leafy vegetables collected from shrubs (8.4%) were available highest in March, i.e., in the summer. Fruits collected from trees (20.6%) were available throughout the year.

4.1.3. Life form and part used

The life form analysis shows that herbs rank first with 40 species (32.5%), followed by trees at 38 species (30.9%), climbers at 25 species (20.3%), and shrubs at 20 (16.3%) species [Figure 4(a)]. Wild fruits were collected from 53 species (41%), leaf and shoot vegetables from 50 species (39.3%), tubers from 8 species (6.5%), shoots from 5 species (4.1%), flowers from 4 species (3.3%), and whole plant from 3 species (2.4%) [Figure 4(b)]. Herbs are a rich source of leaves and shoots (31 species- 25.2%), while trees are a rich source of wild fruits (31 species- 25.4%), and climbers are the only source of tubers (8 species- 6.5%). Herbaceous species belonging to the genus Amaranthus, Digera, Cassia, Cleome, and Cocculus were the primary source of the leafy shoot. Tree genus such as Grewia, Syzygium, Phyllanthus, and Diospyros species were a common source of wild fruits. Similarly, climber species belonging to the genus Dioscorea, Asparagus, Decalepis, and Ceropegia were the common source of the tuber.

Both the communities have 13 varieties of recipes for preparation for WFPs, and most have therapeutic value. Thirty-nine (31.7%) species are consumed raw, 68 (55.3%) in the form of curry or side dish, and 6 (4.9%) in the form of pickle or herbal drink. Many fruits collected from trees (25 species - 20.3%), climbers (7 species - 5.7%), and shrubs (5 species - 4.1%) are eaten raw. The tubers and fruits collected from climbers (4 species - 3.6%) and trees (6 species - 4.8%) are consumed in the form of pickle, herbal drink, or are eaten raw.

4.1.4. Use index

The Use Index (UI) of WFPs varies from 0.01 to 1.0 (Appendix 1). The UI value indicates the number of households using a particular plant species. For instance, Premna tomentosa Willd. (0.1) and Wrightia tinctoria R. Br. (0.1) are used by only 1% of the sampled households. Whereas, plants such as Celosia argentea L. (1.0), Solanum nigrum L. (1.0), and Jasminum *ritchiei* C.B.Clarke (1.0) are consumed by all the sample households every alternative day until the season is over. The WFPs such as Solanum anguivi Lam. and Celosia argentea L., which have high UI, are abundantly found throughout the year. Moreover, a mixture of 8-10 species [Toddalia asiatica (L.) Lam., Senna auriculate (L.) Roxb., Indigofera tinctoriaL., Cordia dichotoma G. Forst., Diospyros Montana Roxb., Commelina diffusa Burm.f., Boerhavia diffusa L., Euphorbia heyneana Spreng., Amaranthus viridis, and Alternanthera sessilis (L.) DC] are commonly used as vegetables for preparing curry or side dishes.

4.1.5. Frequency of foraging

Both the communities use one or the other WFPs throughout the year. The analysis of the frequency of use shows that 28 species, which are leafy vegetables, are used by 80 to 100% households for more than 20 days in a year. About 26 species, including leafy vegetables, are used by 60 to 80% of households for more than ten days in a year. Around 24 species, comprising of leaves, fruits, and shoots are used by 40 to 60% of the households more than five days in a year (Table 3). More than 90% of the households have their recipe that includes WFPs for dinner. Interestingly, Beda Gampana households (85%) use WFPs more than five times a week, whereas the Soliga households (68%) use WFPs 2 to 3 times a week.

4.2. Economic contribution

4.2.1. Socioeconomic profile of the community

It is important to understand the socioeconomic profile of the communities, which has a direct influence on food practices and dietary diversity. The household survey and FGD data reveal that family size, landholding, annual per capita income, literacy level, and knowledge on WFPs use are quite similar. However, the Beda Gampana community with its strict vegetarian diet do not get the special nutritional package (pulses, millets, eggs, ghee, and cooking oil) although they have a high rate of infant mortality. However, the Soliga community gets a special nutritional package from the government (Table 1). This governmental help provides Soliga households with better food security and high dietary diversity than Beda Gampana.

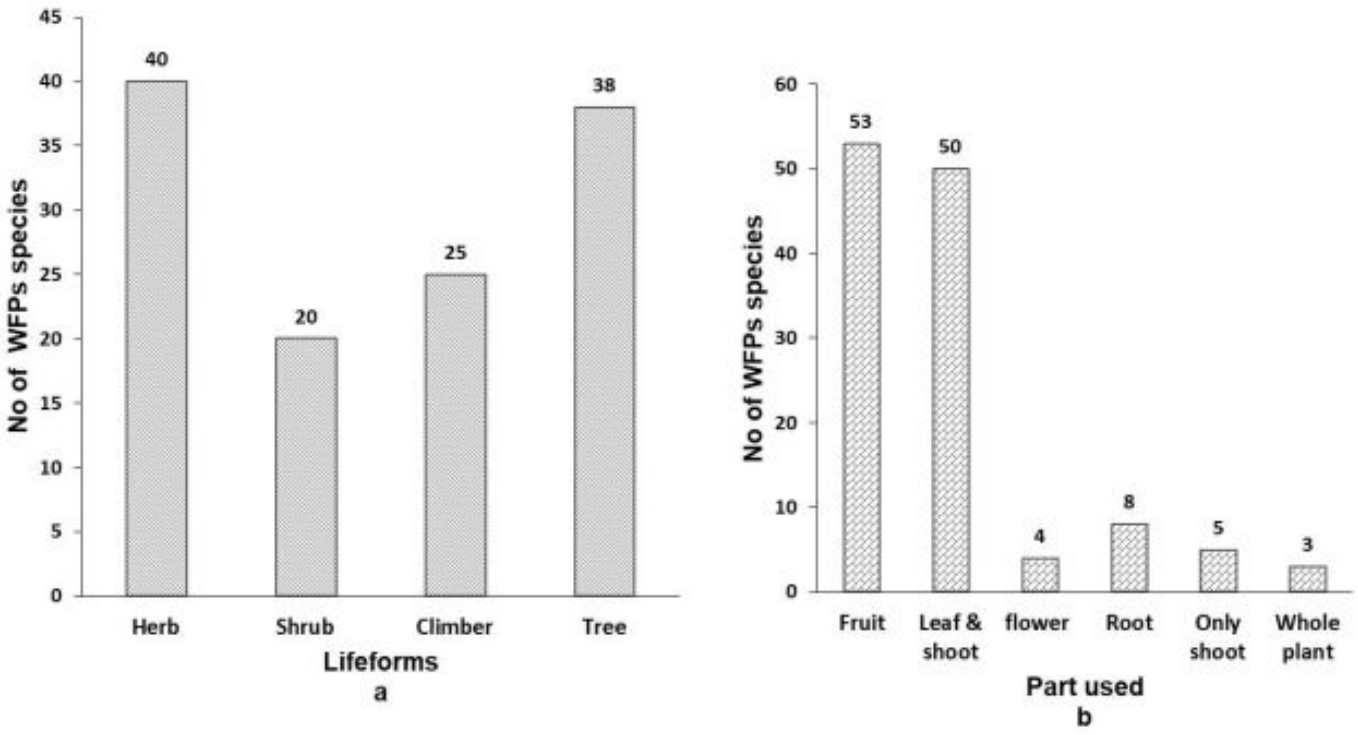


Figure 4. Life form analysis– (a) lifeforms, and (b) part used

Table 3. Foraging frequency and use index value of WFPs

Frequency of Use	No. of Species	Use index (UI=Us/N)	% of Households	Major Species
>20 days /year	28	>0.8	80 to 100	*Jasminum ritchiei, Solanum nigrumL., Celosia argentea, etc.*
10 to 19 days/year	26	0.6 to 0.8	60 to 80	*Cordia dichotoma, Cocculus hirsutus (L.) Diels., Digera muricata, Amaranthus viridis, etc.*
5 to 9 days/year	24	0.4 to 0.6	40 to 60	*Amaranthus polygonoidesL., Alternanthera sessilis, Bacopa monnieri (L.) Pennell, Boerhavia diffusa L.*
2 to 4 days /year	28	0.2 to 0.4	20 to 40	*Coccinia grandis (L.) Voigt, Vachellia farnesiana (L.) Wight & Arn., Solanum torvum Swartz, Euphorbia heyneana, etc.*
One day/year	21	<0.2	0 to 20	*Dioscorea bulbifera L., Grewia hirsute Vahl., Anredera vesicaria, etc.*

ISSN-Internet 2197-411x OLCL 862804632

4.2.2. Time allocation for WFPs forage

Both the communities spend 2 to 3 hours per day during summer to forage WFPs, 1 to 2 hours per day in winter, and 0.5 to 1 hour per day in the rainy season. Since both the communities depend on farming for their subsistence, they spend most of their time farming during the rainy season (4 to 5 months). As leafy shoots are available in plenty in the rainy season, many of them forage close to the village. They forage for leafy shoots/fruits in the farmland itself as part of their farming activity every evening, just before leaving for the village. Winter is also a peak crop harvesting season, and a variety of leafy shoots and fruits are available in and around the farmland. Winter is also peak season for NTFPs collection in the forest. Therefore, they visit the forest more frequently and forage WFPs during NTFPs harvest. Thus, they save time from making separate trips to the forest for foraging WFPs. In summer, very few leafy shoots are available in the forest and farmland, but plenty of tubers and fruits are available in the forest. Therefore, they spend more time foraging for tubers and fruits in the forest.

4.2.3. Importance WFPs income

The main source of income was assessed at the household level for both the Soliga and Beda Gampana communities. The income per capita per year showed that daily wages earned through migration to cities or quarries or coffee plantations were the highest (Soliga - ₹ 13666 and Beda Gampana- ₹ 13595) source for both the communities. Interestingly, WFPs' income per capita/year is ₹ 1459.6 for the Soliga and ₹ 1508.5 for the Beda Gampana communities (Table 4). It shows that income through WFPs is as vital as income from agriculture (Appendix 2). It also reveals that both the communities are equally dependent on WFPs for their food, therapeutic and nutritional needs. Statistically, there was no significant difference in per capita income across both communities to the source of household income (Mann-Whitney pairwise comparison, $p>0.05$).

The economic value for the different parts used from WFPs was calculated at the household level for both the communities. The frequency of WFPs collection, time spent, and prevailing daily wages were used to estimate the economic value of all the 124 plant species. The economic value of leaf and shoots (Soliga- ₹ 740.1±14.7 and Beda Gampana -₹ 815.2±24) were greater than for fruits (Soliga - ₹ 390.0± 23.6and Beda Gampana-₹ 393.0±33.8). The economic value of tubers (Soliga- ₹ 190.6±21.3 and Beda Gampana-₹ 180.9±20.6) was higher than for flowers, seeds, and bark together (Soliga-₹ 187.1±21.5 and Beda Gampana-₹ 156.7± 21.7)(Figure 5).

4.3. Relationship between WFPs use and other livelihood income sources

The correlation coefficient and Wilcoxon signed-rank tests were carried out between WFPs income and livelihood source variables (Table 5). The daily wages were earned through migration to cities/coffee plantations/quarries showed a significant negative relationship with the overall WFPs income (R^2=-0.410, p=0.007), income within the Soliga community (R^2=-0.419, p=0.004), and income within Beda Gampana community (R^2=-0.400, p=0.05).

Landholding and land-use variables showed a very significant positive relationship with WFPs income

Table 4. Household income profile of Soliga and Beda Gampana

Source of income	Soliga(n=92) Mean & Stdev.	Beda Gampana(n=92) Mean & Stdev.
Migration net income/capita/year	₹ 13666.41 ±123.41	₹ 13595.19 ±233.07
Agri net income/acre/capita/year	₹ 1427.81±216.35	₹ 1954.55 ±242.68
Others(Livestock, NTFPs, fuelwood, and crafting) net income/capita/year	₹ 3428.43 ±147.04	₹ 3367.05 ±125.08
WFPs net income/capita/year	₹ 1459.62 ±123.88	₹ 1508.06 ±114.96

overall (landholding R^2=0.244, p=0.0002; land use R^2=0.242, p=0.0002) and Beda Gampana (landholding R^2=0.205, p=0.0002, land use R^2=0.162, p=0.0002). It indicated that households, which have land and do farming, were dependent more on WFPs source. Also, low cash income families (Less than ₹ 5000.0 per family per year) depend more on WFPs than high cash income families.

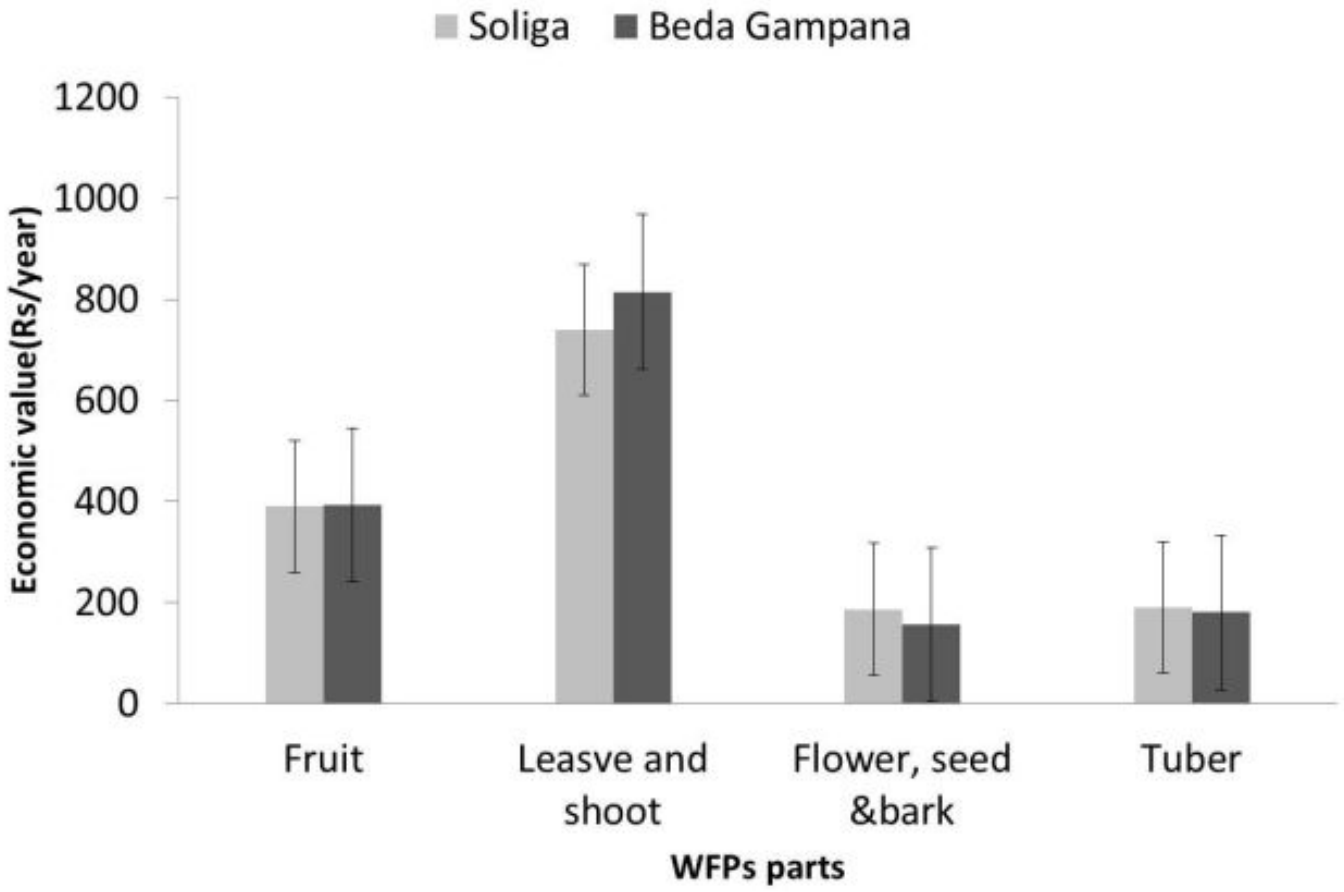


Figure 5. Economic values of different parts used by the communities

Table 5. Wild food plants and income source variables

	Overall		Soliga		Beda Gampana	
Economic Variables	**Correlation with WFPI(R^2)**	***P*-value**	**Correlation with WFPI(R^2)**	***P*-value**	**Correlation with WFPI(R^2)**	***P*-value**
AGRII	0.007	0.02	0.097	0.007	-0.036	0.5
MIGRI	-0.410	0.0007	-0.419	0.004	-0.400	0.05
MFPI	0.293	0.0002	0.172	0.002	0.401	0.0002
LANH	0.244	0.0002	0.282	0.0002	0.205	0.0002
LANU	0.242	0.0002	0.314	0.0002	0.162	0.0002
LIVEI	0.367	0.0005	0.136	0.002	0.416	0.0002
OTHEI	-0.382	0.0005	-0.331	0.005	-0.404	0.0002

WFPI=Wild food plant income; AGRII=Agriculture income; MIGRI=Migration income; MFPI=Minor forest product income; LANH=Land holding size; LANU=Land using size; LIVEI=Livestock income; OTHEI=other income (Business, government or private company employee).

ISSN-Internet 2197-411x OLCL 862804632

4.3.1. Relative importance index of WFPs

The relative importance value of all 124 WFPs was estimated based on the use categories and relative frequency of citation (Appendix 3). The descriptive statistical analyses of these relative citations are shown in Table 6, which shows the mean and standard deviation, and minimum and maximum values for each of the use categories. The maximum relative importance index value was scored by the species *Bambusa bambos* (L.) Voss (0.598), whereas the minimum relative importance index value was scored by the species *Grewiasp*. (0.047). The mean relative importance index value was 0.2± 0.1, and 95 WFPs species scored > 0.1 relative importance index value. It shows that most of the WFPs used by both communities have significant relative importance. Most of the species with higher RII values are of multiple popular uses in the study area.

4.3.2. Relationship between economic and relative importance index

The descriptive statistics on economic and relative importance index values were calculated, which classified the WFPs into very low, low, high, and very high-frequency indices values (Table 7). The maximum economic (2137.5) and cultural index value (2086.0) was scored by Jasminum *ritchiei*, while *Bambusa bambos* (0.60) scored high relative importance index value. The mean economic value index was 217.8 ± 275.8, and the relative importance index value was 0.20±0.10. About 65% of the WFPs species have economic index values >150.0. It shows that more than 70 species contribute to the household economy

Table 6: Descriptive statistical values of ten quantitative indices used to assess relative importance index (RII) of 124 WFPs

	HF	MD	AF	CR	WE	SY	FW	OR	TO	OT	RII
Average	101.3	54.8	86.3	3.4	39.0	8.6	8.0	10.9	6.7	9.7	0.2
Standard eviation	32.5	12.2	22.0	2.7	14.4	2.8	1.3	7.8	1.1	1.2	0.1
Minimum	2	0	0	0	0	0	0	0	0	0	0.05
Maximum	184	184	184	184	184	184	75	134	65	75	0.60

HF=Human food, MD=Medicine, AF=Animal food, CR=Craft, WE=Weed, SY=Symbolic, FW=Firewood, OR=Ornamental, TO=Toxic, OT=Other

Table 7. Descriptive Statistical Values, Frequency, and Percentage of Economic and Relative Importance Values of 124 WFPs Species

	EVI		RII	
Average	217.8		0.20	
Standard deviation	25.8		0.10	
Minimum	18.8		0.05	
Maximum	2137.5		0.60	
Range	**Freq.**	**Per cent**	**Freq.**	**Per cent**
Very low(<0.1)	0	0	28	22.8
Low(<1)	0	0	95	77.2
High(<10)	0	0	0	0
Very high(>10)	124	100	0	0

and the diet of the people in the study area.
The regression analysis shows that the relationship between economic value and use index value is very significant (r^2=0.896, p=<0.001). The WFPs species, which scored high economic values, also had high use-values. Similarly, economic values have a highly significant relationship (r^2=0.624, p=<0.05) with a relative importance index. The study also tested the relationship of economic values with the frequency of citation indices for the Soliga and Beda Gampana communities. Within the community, similar relationships were observed (Table 8). This reveals that perception, use, and indigenous knowledge on WFPs are quite similar between the Soliga and Beda Gampana communities.

The people perceived that WFPs species, which have high economic value, also have high relative importance values. For example, *Bambusa* sp., *Vachellia farnesiana*, *Jasminum ritchiei*, *Amaranthus viridis*, *Solanum nigrum*, *Alternanthera sissilis*, and *Celosia argentea* were cited by people in both the economic and relative importance indices. Similarly, WFPs species with high use index values also have high economic values. For example, *Digera muricata, Cocculus hirsutus, Jasminum ritchiei, Amaranthus viridis, Solanum nigrum, Alternanthera sissilis,* and *Celosia argentea* were cited by the people in both the use and economic index values. Correspondingly, WFPs species with high economic values also had a high frequency of citation. For example, *Digera muricata, Cocculus hirsutus, Jasminum ritchiei, Amaranthus viridis, Alternanthera sissilis,* and *Celosia argentea* were frequently cited by the people in the economic index values. Frequently used WFPs species such as *Bambusa* sp., Vachellia farnesiana, Jasminum *ritchiei*, Amaranthus viridis, Solanum nigrum, Alternanthera sissilis, Digera muricata, Cocculus hirsutus, and Celosia argentea have high economic and use index values. It indicates their significant role in the diet, as material, and in medicine (Appendix 4).

5. Discussion

5.1. Dependency on WFPs resource and knowledge of the use

Despite significant socioeconomic changes and globalization, residents belonging to the Soliga and Beda Gampana communities in the MM Hills still depend on many WFPs as well as use these in their daily diet. Both the communities use one or the other WFPs throughout the year every alternate day. The WFPs are a vital source of micronutrients for Beda Gampana communities who have a strictly vegetarian diet. Beda Gampana communities have a more profound knowledge of the collection, preparation, and therapeutic usage of WFPs compared to Soliga communities. More than 124 WFPs species were used as vegetables, fruits, beverages, for food therapy, for economic benefit, and cultural and religious practices. Family structure, economic status, and occupation of the members of the households determine their dependency on the WFPs. Women have more knowledge of WFPs than men, and older people have more knowledge of the number of WFPs known and its usage than younger people (Harisha *et al.,* 2015). The knowledge of use and dependency on WFPs for women and older people is critical for survival, while it is not so for the present younger generation since their food habit and lifestyle is changing rapidly.
The surrounding habitat is the prime source of WFPs

Table 8. Sensitivity analysis: regression of the values between economic value and UI and RII

Index values	Overall		Soliga		Beda Gampana	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
UI (Use Index)	0.896	<0.001	0.847	<0.001	0.903	<0.001
EVI (Economic values index)	0.624	<0.05	0.713	<0.05	0.816	<0.001
RII (Relative importance index)	0.784	<0.001	0.803	<0.001	0.792	<0.001
FC (Frequency of citation)	0.693	<0.001	0.712	<0.001	0.703	<0.001

ISSN-Internet 2197-411x OLCL 862804632

and frequently cited by local people indicating the importance of the species in the region. Communities depend on WFPs species for their food and medicine; they had in-depth knowledge of the distribution and availability of these WFPs. Many studies have shown that the occurrence of wild leafy vegetables and fruits in the vicinity of the villages offers a unique opportunity for agroforestry species conservation (Sansanelli *et al.,* 2017; Shumsky *et al.,* 2014). Therefore, it is essential to document the use, knowledge, and conservation of WFPs, which offer a wide range of uses in rural households.

The distribution patterns were shared across the arid tropical forest habitat. WFPs species are well-adapted to the climate and geographical conditions. The existence of these taxa in the different regions of the country indicates their wide range of ecological adaptation and their palatability to different ethnic communities (Bharucha& Pretty, 2010; Major 2013). Shrub species belonging to the genus Jasminum, Solanum, and Acacia are common in both farm and forest habitats. These species survive in highly disturbed habitats and have a wide range of distribution across disturbance gradients, geographic, and climatic conditions.

5.2. Seasonal availability, diversity, and dependency

The usage and seasonal availability of WFPs positively correlated. The local communities are aware of the seasonal plant availability and their phenological status (Harisha*et al.,* 2013). Many studies across the world have revealed that plenty of shoots and wild leafy vegetables are available in the rainy season compared to the dry season (Joshi *et al.,* 2015). Similarly, many wild fruits ripen in the winter and are available for consumption (Harisha *et al.,* 2013). It is true that without WFPs, the local people, especially Beda Gampana communities who solely depend on the plant as the primary source of food and practices in MM Hills would have lesser food security and may suffer malnutrition. Both the Soliga and Beda Gampana communities had tremendous knowledge of phenology and the ecological aspect of WFPs. However, Bed Gampana had a deep knowledge of the preparation of food concerning season and their part.

It is well-recorded by many studies that herbs are the prime sources of leafy vegetables in many rural parts of the country (Osewa *et al.,* 2013; Geng *et al.,* 2016). The diversity of use of different parts of WFPs in different seasons of the year has great potential to combat food insecurity and offer nutritional security during drought years (Grivetti & Ogle, 2000; Lulekal *et al.,* 2011). This is especially true in the case of tubers and fruits, which provide essential nutrients to rural households in the summer and drought years (Bhatia *et al.,* 2018). Both the study communities consume more leafy vegetables from herbs, shrubs, and trees, which are available in plenty across the seasons. Sometimes the WFPs is the only source of nutrition and remedy for common health problems in the study area.

WFPs are still crucial in many areas today, and in exceptional cases, maybe the only source of food available (Geng *et al.,* 2016). The Soliga and Beda Gampana communities regularly use 43 WFPs species. In comparison, another 28 WFPs species that are often ignored in regular times become vital when there is a shortage of food grains or drought. The local people repeatedly mentioned this during the interviews.

Seasonality of the agricultural cycle and wild food plant availability is usually linked to rainfall in tropical countries (Bharucha & Pretty, 2010). For example, the human inhabitants of rain forests suffer mild to severe hunger nearly the same time every year, leading to weight loss, which is a matter of serious public health concern (Milow *et al.,* 2011; Raghavendra *et al.,* 2017). Similarly, in tropical dry forest regions, local communities face food shortages from July to October every year (Singh *et al.,* 2016). Seasonality has a critical effect on the nutritional status of young children (between 12 and 24 months) and may expose them to severe malnutrition in the lean period (Madegowda, 2009; Harisha *et al.,* 2015).

5.3. WFPs use and its economic importance

The study revealed that both communities use different parts of the WFPs equally. Previous studies have developed the indices of economic and relative importance index that captures the multiple uses of the plants (Sansanelli *et al.,* 2017; Shumsky *et al.,* 2014). Most of the studies have merged different approaches to allow a more comprehensive valuation of the importance of the WFPs for human well-being (Agea *et al.,* 2011; FAO, 2014; Gracia *et al.,* 2015). These indices measured the use-value of WFPs spe-

cies. For example, WFP species mentioned with higher frequency for a particular use was assigned more use-value than plants mentioned with less frequency. A few studies also focused on estimating the economic value of WFPs for different human societies (Kalita *et al.,* 2014; Geng *et al.,* 2016). The present study indicates that WFPs are mainly used to supplement staple food and to fill-in food gaps. The higher number of plant citations by the communities in the study area indicates a high consumption level and familiarity with these plants. It is a common phenomenon that at times of seasonal food shortages when household stocks were empty and the new crop was still in the field, were typically periods of intensive collection and consumption of WFPs (Kothari *et al.,* 2012; Tsering *et al.,* 2014). Similar findings were recorded by many studies across the globe (Thakur *et al.,* 2017; Joshi *et al.,* 2015). WFPs, therefore, serve as a reliable safety net and provide households with the opportunity to save on the costs of buying food.

The majority of the households consume WFPs daily, indicating the role of WFPs in the diet of the people. The positive relationship between land-based livelihood sources (i.e., crops, NTFPs, and livestock) is an indication of their concurrent relevance to the livelihood (Harish *et al.,* 2015). It has a greater significant relationship with land-based livelihoods and dependency on WFPs for Beda Gampana communities than Soliga. It indicates that WFPs are very important for Beda Gampana communities irrespective of household income and literacy to meet their nutritional needs. Similarly, the monetary value of WFPs to the households is significant compared with NTFPs. The benefits of WFPs resources to forest-dependent communities in the semi-arid tropical region of the country are immense. They can no longer be neglected in national and regional resource accounting. Similar results were recorded in many studies that WFPs use is not only crucial for food and nutritional security, but also to the socio-economy of the local communities (Gracia *et al.,* 2015; Tsering *et al.,* 2014). Studies also describe the relevance and importance of WFPs in rural farming communities (Agea *et al.,* 2011; Tsering *et al.,* 2014; Salvi & Katewa, 2016). The indices provide an understanding of diversity, complexity, and appreciation of these WFPs use systems by the indigenous people in the study area.

The study found a high connection between the economic values and relative importance values of the WFPs. This study also found an association between the income level of the households and their use of the WFPs. The study also demonstrates the high rate of dependency on the use of WFPs. Multiple indices value improves the understanding of the importance of WFPs species. Similarly, observations were recorded in many studies using multiple indices to measure the different aspects of the importance of WFPs for people (Gracia *et al.,* 2015). The advantage of the combination of the three indices offers a more comprehensive valuation of the significance of the plants for local communities than one might obtain from using only a single index (Agea *et al.,* 2011; Raghavendra *et al.,* 2017). Further comprehensive multiple indices would be useful for a better understanding of the issues of conservation and sustainable management of WFPs resources in the study area.

6. Conclusion

The dependency on WFPs resources is inevitable and critical to meet the dietary, therapeutic, socioeconomic, and cultural practices of both the communities. The economic value of WFPs for households is as important as the crops grown for subsistence in both the communities. It revealed that households, which follow the traditional occupation, were still dependent on WFPs for food and other uses than households with non-traditional occupations such as migration, business, and urban labour work. It is a common phenomenon in traditional occupation households that seasonal food shortages faced when the new crop is still in the field are periods of intensive collection and consumption of WFPs. The reliance on WFPs is, therefore, a safety net and vital source of nutrition especially, for the Beda Gampana community who have a strictly vegetarian diet. The WFP's source, availability, and diversity are critically important for Beda Gampana households in MM Hills.

Emphasizing the improvement of nutrition and health through initiatives that protect WFPs diversity and related traditional knowledge systems is critical. Towards this, a systematic review of WFPs resources at the regional and national level with local consultation is necessary. Understanding the role of WFPs in food, nutrition, culture, and economics of the local communities is imperative. The benefits of WFPs resources to the forest-dependent community in the

ISSN-Internet 2197-411x OLCL 862804632
UniKassel & VDW, Germany-May 2021

semi-arid tropical region of the country are vast, and they can no longer be neglected in national and regional resource accounting. Most importantly, to address the challenges posed by recent climate change issues, financial crisis, and their implications on food and nutritional security, the use of WFPs in the diet becomes crucial.

Conflict of Interest

The authors declare that there is no conflict of interest.

Acknowledgement

The authors would like to thank the communities for freely sharing their knowledge. The authors also thank the Salur Mutt, Indian Meteorological Department, Statistical Department, and the Social Welfare Department for generously sharing information. The authors acknowledge the participation of Soliga and Beda Gampana community members and Mr. Madesha, Mr. Narayanan, Ms. Puttamma, and Mr. Thamme Gowda for their help in the collection of data. The permission of the Karnataka Forest Department is gratefully acknowledged.

References

Agea, J.G., Okia, C.A., Obua J., Hall J., and Teklehamanot Z. (2011). Wild and semi-wild food plants in the Bunyoro-Kitara Kingdom, Uganda: Cultural significances, local perceptions, and social implications of their consumption. International Journal of Medicinal and Aromatic Plants, 1(2): 137-152.

Arya D. (2013). Major wild edible fruits used by the locals of Garhwal Himalaya. International Journal of Advanced Life Sciences, 6(3): 145-9.Bharucha, Z., and Pretty, J. (2010). The roles and values of wild foods in agricultural systems. Philosophical Transactions of the Royal Society B: Biological Sciences, 365: 2913-2926.

Champion, H. G. and Seth, S. K. (1968). A Revised Survey of the Forest Types of India. Published by Govt. of India Press.

Deepika Thakur, Alpy Sharma, and Sanjay Kr. Uniyal. (2017). Why they eat, what they eat: patterns of wild edible plant consumption in a tribal area of Western Himalaya. Journal of Ethnobiology and Ethnomedicine, 13: 70.

De Lucena, R.F.P., E. de Lima Araujo, and U.P. De Albuquerque. (2007). Does the local availability of woody Caatinga plants (North-eastern Brazil) explain their use value? Economic Botany, 61: 347-361.

Ermias Lulekal, ZemedeAsfaw, EnsermuKelbessa, and Patrick Van Damme (2011).Wild edible plants in Ethiopia: A review on their potential to combat food insecurity. afrika focuses, 24 (2): 71-121.

Food and Agriculture Organization of the United Nations(2014). State of the World's Forests. Rome. http://www.fao.org/3/a-i3710e.pdf

Food and Agriculture Organization of the United Nations (2017). The state of food security and nutrition in the world 2017: building resilience for peace and food security. Rome. http://www.fao.org/3/a-i3710e.pdf

Gamble, J.S. (1957). Flora of the Presidency of Madras. Botanical Survey of India, Calcutta.

Geng Y, Zhang Y, Ranjitkar S, Huai H, Wang Y. (2016). Traditional knowledge and its transmission of wild edibles used by the Naxi in Baidi Village, northwest Yunnan province. Journal of Ethnobiology and Ethnomedicine, 12:10.

Grivetti, L. E., and Ogle, B. M. (2000). Value of traditional foods in meeting macro- and micronutrient needs: the wild plant connection. Nutritional Research Review, 13: 31–46.

Harisha, R.P. and Padmavathy, S. (2013). Knowledge and use of the wild edible plant in two communities in MalaiMadeshwara Hills, Southern India. International Journal of Botany, 9(2): 64-72.

Harisha, R.P., Padmavathy, S., and Nagaraja B.C. (2015). Traditional Ecological Knowledge (TEK) and its importance in South India: Perspective from the local community. Applied Ecology and Environmental Research, 14(1): 311-326.

Harpreet Bhatia , Yash Pal Sharma , R. K. Manhas, and Kewal Kumar (2018).Traditionally used wild edi-

ble plants of district Udhampur, J&K, India. Journal of Ethnobiology and Ethnomedicine, 14: 73.

Helen Newing, Christine Eagle, RajindraPuri, and C.W. Watson (2011). Conducting research in the conservation of a social science perspective. Routledge Press, 98-104.

Indian Meteorological Data (2016). http://www.imd.gov.in

International Society of Ethnobiology the code and ethics. (2013). http://www.ethnobiology.net/what-we-do/core-programs/ise-ethics-program/code-of-ethics/

Joshi N, Siwakoti M, Kehlenbeck K. (2015). Wild vegetable species in Makawanpur District, Central Nepal: developing a priority-setting approach for domestication to improve food security. Econ Bot, 69(2): 161–70.

Jyotsna Salvi, Katewa SS. (2016). A review: Underutilized wild edible plants as a potential source of alternative nutrition. International Journal of Botany Studies, 1(4): 32-36.

Kalita, P., Tag, H., Sarma, H.N., Das, A.K.(2014). Evaluation of Nutritional Potential of Five Unexplored Wild Edible Food Plants from Eastern Himalayan Biodiversity Hotspot Region (India). International Journal of Biological, Veterinary, Agricultural, and Food Engineering, 8(3): 209-212.

Kothari, Ashish, NitinRai, and Madegowda, C. (2012). "Green approach, An alternative conservation model for the BRT Sanctuary is a step closer to becoming reality". Conservation. Frontline, 29 (1): 9-102.

Madegowda, C. (2009). Traditional Knowledge and Conservation. Economic and Political Weekly, May 23, 14:21.

Mala Rathore. (2009). Nutrient content of important fruit trees from the arid zone of Rajasthan. Journal of Horticulture and Forestry, 1 (7): 103-108.

Ojee s. and Kaku Didi E.K. (2015). Wild edible plant species utilized by a subsistence farming community in Obalanga sub-county, Amuria district, Uganda. Journal of Ethnobiology and Ethnomedicine,v11(1):7.

Ong H.C., P. F. J. Mojiun, and P. Milow(2011). Traditional knowledge of edible plants among the Temuan villagers in KampungGuntor, Negeri Sembilan, Malaysia. African Journal of Agricultural Research, 6(8): 1962-1965.

Osewa SO, Alamu O, Adetiloye IS, Olubiyi MR, Abidogun EA. (2013) Use of some Neglected and Underutilized Plant Species among Rural Dwellers in Akinyele Local Government Area of Oyo State. Greener. Journal of Agricultural Sciences, 3(12):817-822.

Phillips, O., and A.H. Gentry (1993). The useful plants of Tambopata, Peru: I. Statistical hypotheses tests with a new quantitative technique. Economic Botany, 47: 15-32.

Pieroni, A. (2001). Evaluation of the cultural significance of wild food botanicals traditionally gathered in northwestern Tuscany, Italy. Journal of Ethnobiology, 89–104.

Puri, R.K. (2015).The uniqueness of every day: Herders and invasive species in India. In Barnes, J. and M. Dove, eds., Climate Cultures: Anthropological Perspectives on Climate Change. Agrarian Studies Series, Ch 10: 249-72, New Haven: Yale University Press.

R Core Team (2013). A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.https://www.r-project.org/

Raghavendra Naik, Sneha D. Borkar, Sulochana Bhat, Rabinarayan Acharya. (2017). Therapeutic potential of wild edible vegetables - A Review Journal of Ayurveda and Integrated Medical Sciences, 2(6): 85-97.

Reyes-Garcia V, Menendez-Baceta G, Aceituno-Mata L, Acosta-Naranjo R, Calvet-Mir L, Dominguez P, Rodriguez-Franco R. (2015). From famine food to delicatessen: interpreting trends in the use of wild edible plants through cultural ecosystem services. Ecological Economics, 120:303–11.

Saldanha, C.J., and D.H. Nicholson (1976). The Flora of Hassan District. Karnataka, Amerind Publishing

ISSN-Internet 2197-411x OLCL 862804632

Co. Pvt. Ltd., New Delhi, India.

Sansanelli S., Ferri M., Salinitro M., and Tassoni A. (2017). Ethnobotanical survey of wild food plants traditionally collected and consumed in the Middle Agri Valley (Basilicata region, Southern Italy). Journal of Ethnobiology & Ethnomedicine,13(1):50.

Santayana (2003a). The Letters of Gorge Santayana, Book One ([1868]-1909),Fernholz-Berger W.G.&Saatkamp Jr., H.J.(eds.), The Works of George Santayana, Volume V, Cambridge(Ma.) & London, The MIT Press.

Shumsky, S.A., Hickey, G.M., Pelletier, B., and Johns T. (2014).Understanding the contribution of wild edible plants to rural social-ecological resilience in semi-arid Kenya. Ecology & Society, 19(4).

Singh B, Sultan P, Hassan QP, Gairola S, Bedi YS. (2106). Ethnobotany, traditional knowledge, and diversity of wild edible plants and fungi: a case study in the Bandipora district of Kashmir Himalaya, India. Journal of Herbs, Spices, and Medicinal Plants, 22(3):247–78.

Tag, H., Tsering, J., Hui PK, Gogoi, B.J. Veer, V. (2014). Nutritional potential and traditional uses of high altitude wild edible plants in the eastern Himalayas, India international. Journal of biological, veterinary, agricultural, and food. Engineering. 8(3):226–31.

Tebkew M, Asfaw Z, Solomon Z. (2014). Underutilized wild edible plants in the Chilga District, northwestern Ethiopia: focus on wild woody plants. Agriculture & Food Security, 3(12): 1-16.

Uma Shaanker R., K.N. Ganeshaiah, Smitha Krishnan, R. Ramya, C. Meera et al. (2004). Livelihood gains and ecological costs of non-timber forest product dependence: assessing the roles of dependence, ecological knowledge, and market structure in three contrasting human and ecological settings in south India. Environmental Conservation, 31(3): 242–253.

Victoria Reyes-Garcia, Tomas Huanca, Vincent Vadez, William Leonard, DawidWilkie. (2006). Cultural, Practical and Economic value of Wild Plants: A quantitative study in the Bolivian Amazon, Economic Botany, 60 (1): 62-74.

ISSN-Internet 2197-411x OLCL 862804632

Future of Food: Journal on Food, Agriculture and Society
9 (2) May 2021

Climate change impact on economic and irrigation requirements for sugarcane crop in Egypt

M. A. A. Abdrabbo[1,*], Farag, A. A[1], H. A. Radwan[2], M. A. M. Heggi[1], H M Aboelsoud[2], Chetan Singla[4] and Rakesh Sharda[5]

[1]Central Laboratory for Agricultural Climate, Agricultural Research Center, Dokki 12411, Giza-Egypt
[2]Agricultural Engineering Research Institute, Agricultural Research Center, Dokki, Giza-Egypt
[3]Soil, Water and environment Research Institute, Agricultural Research Center, Dokki, Giza-Egypt
[4]Department of Soil & Water Engineering, Punjab Agricultural University, Ludhiana-141004, Punjab, India
[5]Office of Director (Farm), Punjab Agricultural University, Ludhiana-141004, Punjab, India

* Corresponding author: abdrabbo@yahoo.com

Data of the article

First received : 08 March 2020 | Last revision received : 28 October 2020
Accepted : 02 December 2020 | Published online : 12 February 2021
DOI : 10.17170/kobra-202011192212

Keywords

Evapotranspiration, GIS, water use efficiency, climate change scenarios, adaptation options .

Availability of irrigation water is considered one of the major challenges faced by Egypt currently and will become increasingly difficult in the future due to the limited water resources and linear increase of population. The current study investigates irrigation demand for sugarcane cultivation areas in the Middle and Upper Egypt Governorates (Menia, Asyut, Sohag, Qena, Luxor and Aswan) during present times and under representative concentration pathways (RCP) scenarios. The data was collected within the period between 1971 and 2000, and the RCP data were collected for different scenarios (RCP 3, RCP 4.5, RCP 6 and RCP 8.5) during three-time series (2011-2040, 2041-2070 and 2071-2100). The highest evapotranspiration (ETo) values during current and future conditions were found in Luxor and Aswan governorates; while the lowest ETo values were recorded in Menia and Asyut. All RCPs scenarios were significantly higher than the current conditions. Moreover, the highest irrigation requirements under RCP scenarios were recorded in Aswan and Luxor under RCP 8.5 during 2071-2100 time series. While Menia, under RCP3 at 2011-2040 recorded the lowest irrigation water needs under climate change. Interpolated maps were done for the clear appearance of the difference between water requirements under different climatic condition. The advantage of the current work was to give a clear vision related to the economic status of irrigation water management under current and future conditions for one of the major crops in Egypt.

1. Introduction

Sugarcane is considered the main ingredient source for the sugar and molasses industry in Egypt. Besides, Egyptian consume it fresh or as juice, and the industry by-products are used in the ethyl alcohol, active yeast, citric and acetic acid, paper and pulp industries (El-Kholi, 2008). The agriculture sector is considered to be one of the most prominent water-consuming sectors, totalling 82% of all consumption or 75 billion cubic meters. Irrigation water is a vital element in agriculture and the basis for agricultural expansion. Therefore, the problem of limited water resources and the subsequent low efficiency of irrigation limits the possibility of more land reclamation. Egypt is classified as a water-poverty country, which means that it is unable to provide food and employment opportunities (Yasmen, 2015). The limited water resources weigh negatively on the cultivation of sugarcane that needs nearly 13-15 thousand cubic meters of water per feddan (one feddan equal 4200 m2), compared to 2.5-3.0 thousand cubic meters for the sugar beet.

Agriculture is the basis for Egypt's economy, and one of the primary sources of income for almost half of the Egyptian population and therefore plays a vital role in sustainable economic development. Also, the agricultural sector provides raw materials for industrial purposes. The sustainability of these roles requires economic development derived from two main factors, increase the productivity per water unit and increase the cultivated area (Farag *et al.,* 2017). Current and future water resources are the limiting factor among the other economic production factors (Raouf, 1996). The economy in Upper Egypt is heavily dependent on refined sugarcane sugar. The cultivation of sugarcane in Upper Egypt is directly connected with the livelihoods of 200,000 families (sugarcane farmers). Almost 5.3 million people are dependent on sugarcane growing and sugar production. Nearly 300,000 families are connected to the sugarcane business indirectly (Omar and Tate, 2019). Furthermore, sugarcane is preferred over beets in the climate change scenario because of the attractive price offered by the government, making it the cash crop (Elasraag, 2019).

However, high temperatures are likely to negatively affect water management practices for agriculture under the current climate conditions. An increase in water demand for irrigation is projected under a warmer climate (Krol & Bronstert, 2007). Climate change will increase the average daily air temperature for each climate region, which leads to increased daily evaporation and then increased irrigation water needs. It is well known that climate change is considered a challenge for irrigation system capacity to meet the anticipated increase in net daily evaporation. Higher evaporation due to high temperatures can result in drought stress in sugarcane fields; higher irrigation quantities with more frequent irrigation events will have to be done to meet higher irrigation water demands (Chandiposha, 2013).

The RCPs are called 'Representative Concentration Pathways' because they were developed to be 'representative' of possible future emissions and concentration scenarios published in the IPCC's fifth assessment report (IPCC, 2013). Irrigation water requirements were projected to increase by around 50% in developing regions and 16% in developed regions. Knox *et al.* (2010) used the DSSAT-Canegro model to predict that expected climate change in the 2050s could increase sugarcane irrigation requirements in Swaziland by +9%, and sucrose yields by about 15%. Conventional irrigation methods are not appropriate to sugarcane with limited irrigation water availability; the irrigation sector in Egypt faces a rapid decline in the availability of irrigation water and low water-use efficiency in the flood irrigation method (conventional) (Hanafy *et al.,* 2008).

Water pumps are often used continuously over hours, and as a result, they account for a large part of fuel consumption and CO2 emission of general-purpose. Therefore, the fuel consumption of such pumps should be improved. Previous studies forecasted that water pumps would account for 85% of fuel consumption and CO2 emissions of agriculture machinery (tractor, mower, power carrier, tiller and water pump) (Naohiro & Takahide, 2015). The increase in diesel price led to renewed interest in conducting efficiency evaluations method of diesel irrigation pumping (Henggeler *et al.,* 2004). The target of this study is to estimate the trend of temperature, reference ETo and water irrigation demands for sugarcane crop under climate change conditions according to IPCC fifth assessment report (RCP scenarios) in six governorates.

2. Material and methods

2.1. Study area

Egypt has several recognised agro-climatic regions according to climatic data. Upper Egypt and south of Middle Egypt are considered the most critical agro-climatic regions for sugarcane production. The studied area from North to South contained six governorates: Menia, Asyut, Sohag, Qena, Luxor and Aswan. The daily historical climate data of minimum and maximum air temperature, relative humidity, wind speed and solar radiation were collected from the Central Laboratory for Agricultural Climate and Egyptian Authority of Meteorology. The average monthly data from 1971 to 2000 were estimated from the collected daily data. The data for different locations were collected from meteorological stations of the different regions. The coordinates of the concerned automated weather stations are presented in Table (1).

2.2. Climate change scenarios

The IPCC released a set of climate change scenarios based on representative concentration pathways

Table 1. The coordinates of automated weather stations used in this study

No.	Station	Latitude (°N)	Longitude (°E)	Altitude (m)
1	Menia	28.5	30.4	44
2	Asyut	27.3	31.2	56
3	Sohag	26.6	31.6	68
4	Qena	26.1	32.7	72
5	Luxor	25.4	32.5	80
6	Aswan	24.0	32.9	108

(RCPs) (Ritchie & Dowlatabadi, 2017). The RCP scenarios involve widely differing emissions pathways, reflecting different levels of effectiveness in tackling emissions and climate change (IPCC, 2013).

2.3. Data and Projections

The data projection was customised to the Middle and Upper Egypt regions in six governorates (Menia, Asyut, Sohag, Qena, Luxor and Aswan), downscaled climate data for these governorates were drawn from ClimaScope website http://climascope.tyndall.ac.uk.

2.4. ETo calculation

ETo is a measure of crop water use and was calculated, for both, current and future conditions using the Food and Agricultural Organization (FAO-56) Penman-Monteith (PM) procedure presented by Allen *et al.* (1998). The FAO Penman-Monteith equation predicts the evapotranspiration from a hypothetical grass reference surface that is 0.12 m in height having a surface resistance of 70 s m-1 and albedo of 0.23. The equation provides a standard to which evapotranspiration can be computed. The evapotranspiration from other crops can be related in different periods of the year or other regions.

2.5. Irrigation requirement for sugarcane

The irrigation requirements for sugarcane are calculated according to Allen *et al.* (1998). The irrigation requirement for sugarcane was estimated according to the following equation:

$$IR = (ETo * Kc) + LR * Ea * 4.2$$

Where:

IR= irrigation requirement for sugarcane m3 / feddan/ day
Kc= Crop coefficient [dimensionless].
ETo= Reference crop evapotranspiration [mm/day].
LR= Leaching requirement LR (%) (assumed 20% of the total applied water).
Ea= efficiency of the irrigation application (50% flood irrigation and 80% gated pipes)
4.2= to convert water requirements from millimetre per day to cubic meter per feddan per day (Feddan = 4200 m2)

2.6. Interpolation technique (GIS)

The ordinary kriging interpolation method is a standard technique for spatial interpolation (Farag *et al.* 2014). It provides each cell with a local, optimal prediction and an estimation of the error that depends on the variogram and the spatial configuration of the data. Kriging with external drift incorporates secondary information into the kriging system when the main and second variables are correlated (Esri, 2012). In our case, altitude was evaluated as a secondary variable. Although similar to universal kriging, it uses an ancillary variable, which varies smoothly in space, to represent the trend instead of the spatial coordinates (Goovaerts, 2000).

2.7. Estimate pumping water cost per hour

Pumping costs: Pumping water costs were divided into two main categories: (i) fixed cost and (ii) operating costs, which vary directly with the number of operating hours. The calculation assumed the pumps to have 150 -200 m3/h discharge, engine power 8 horsepower, and fuel consumption of 0.12 L/horsepower/hour (L/hp/h). The value of these costs can be estimated by making a few assumptions about machine

ISSN-Internet 2197-411x OLCL 862804632

life, annual use, fuel and labour prices (Thompson *et al.,* 2002). Fixed costs included depreciation, interest (opportunity cost), taxes, insurance, and housing facilities. Variable costs included repairs, maintenance, fuel, lubrication, and operator labour. The average cost of pumping one cubic meter of water was estimated by 0.12 L.E. (Egyptian pound) according to Hanafy *et al.* (2008).

2.8. Statistical analysis

Statistical analysis was carried out using SAS software. The paired t-test was used to establish whether there exist significant differences in the current ETo from 1998 to 2007 and estimated ETo under climate change in the 2050s, 2100s at significant level 0.05 (SAS, 2000).

3. Results and discussion

3.1. Trend of ETo, current and future

The average monthly ETo values for the concerned governorates under current and future (2011-2040, 2041-2070 and 2071-2100) conditions are presented in Tables (2 and 3). Table 2 represents the Menia governorate or Middle Egypt governorates whereas Table 3 represents the Aswan governorate or the Upper Egypt governorate. The other studied governorate is tabulated in the annexe. There were significant differences among the irrigation requirement under current and future scenarios.

Data indicated that the highest monthly ETo values during current and future conditions was found in Luxor and Aswan; while the lowest ETo values were recorded in Menia. The highest monthly ETo values for the concerned region under the current situation was recorded during the summer months (June, July and August), while the lowest monthly ETo was recorded in the winter months (December, January and February). Concerning the monthly ETo in the different studied time series (2011-2040, 2041-2070 and 2071-2100), all scenarios expected significant increase of ETo values in different studied time series compared to current climatic conditions.

The lowest ETo values were projected under RCP3; while the highest was expected under RCP8.5 in all governorates. All ETo values under climate change scenarios were significantly higher than the current conditions. We can conclude that all RCP scenarios were significantly higher than the current conditions. Moreover, the highest ETo under RCP scenarios was recorded in Aswan and Luxor under RCP 8.5 during 2071-2100 time series. In contrast, the lowest ETo under climate change were found in Menia under RCP3 during 2011-2040 time series.

Table 2. Average reference ETo under current and future conditions at Menia Governorate

	Current	RCP 3			RCP4.5			RCP 6			RCP 8.5		
month	1971-2000	2011-2040	2041-2070	2071-2100	2011-2040	2041-2070	2071-2100	2011-2040	2041-2070	2071-2100	2011-2040	2041-2070	2071-2100
Jan	2.71	2.89	3.12	3.36	2.88	3.01	3.09	2.87	2.99	3.15	2.89	3.12	3.36
Feb	3.37	3.64	3.87	4.13	3.61	3.76	3.85	3.59	3.75	3.92	3.64	3.87	4.13
Mar	5.60	5.96	6.31	6.68	5.96	6.13	6.22	5.94	6.09	6.34	5.96	6.31	6.68
Apr	8.08	8.46	9.07	9.71	8.44	8.76	8.98	8.44	8.75	9.11	8.46	9.07	9.71
May	10.52	10.96	11.60	12.34	10.95	11.28	11.49	10.93	11.22	11.73	10.96	11.60	12.34
Jun	10.92	11.58	12.25	13.15	11.47	11.95	12.18	11.39	11.87	12.45	11.58	12.25	13.15
Jul	10.16	10.73	11.56	12.47	10.67	11.17	11.42	10.66	11.06	11.65	10.73	11.56	12.47
Aug	9.17	9.76	10.59	11.50	9.76	10.24	10.44	9.73	10.14	10.74	9.76	10.59	11.50
Sep	7.69	7.98	8.49	9.04	7.95	8.24	8.40	7.92	8.19	8.54	7.98	8.49	9.04
Oct	5.80	6.15	6.61	7.12	6.14	6.37	6.52	6.10	6.33	6.65	6.15	6.61	7.12
Nov	3.66	3.95	4.24	4.55	3.93	4.09	4.18	3.91	4.08	4.26	3.95	4.24	4.55
Dec	2.60	2.82	3.04	3.29	2.81	2.92	3.00	2.79	2.90	3.06	2.82	3.04	3.29
average	6.69	7.07	7.56	8.11	7.05	7.33	7.48	7.02	7.28	7.63	7.07	7.56	8.11
P-Value		*	*	*	*	*	*	*	*	*	*	*	*

**** Significant at P < 0.05***

Table 3. Average reference ETo under current and future conditions at Aswan Governorate

	Current	RCP 3			RCP4.5			RCP 6			RCP 8.5		
month	1971-2000	2011-2040	2041-2070	2071-2100	2011-2040	2041-2070	2071-2100	2011-2040	2041-2070	2071-2100	2011-2040	2041-2070	2071-2100
Jan	3.24	3.45	3.55	3.55	3.48	3.70	3.82	3.45	3.69	3.95	3.50	3.88	4.33
Feb	5.60	5.89	6.01	5.99	5.90	6.14	6.27	5.89	6.12	6.42	5.95	6.39	6.79
Mar	6.80	7.18	7.36	7.36	7.21	7.54	7.70	7.18	7.52	7.89	7.25	7.78	8.43
Apr	10.80	11.19	11.37	11.37	11.22	11.62	11.89	11.19	11.59	12.06	11.23	12.00	12.84
May	12.40	12.85	13.00	13.00	12.86	13.00	13.00	12.82	13.00	13.00	12.88	13.00	13.00
Jun	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00
Jul	13.48	14.06	14.30	14.30	14.06	14.61	14.84	14.04	14.52	15.00	14.08	15.00	15.00
Aug	12.26	12.98	13.00	13.00	12.99	13.00	13.00	12.96	13.00	13.00	13.00	13.00	13.00
Sep	11.02	11.40	11.57	11.56	11.40	11.82	12.05	11.39	11.76	12.23	11.42	12.13	12.96
Oct	9.71	9.99	10.17	10.13	9.99	10.43	10.63	9.99	10.34	10.77	10.09	10.69	11.41
Nov	5.91	6.26	6.37	6.36	6.29	6.55	6.70	6.25	6.55	6.83	6.29	6.80	7.33
Dec	4.20	4.43	4.56	4.55	4.44	4.67	4.81	4.43	4.64	4.93	4.49	4.86	5.33
average	9.12	9.47	9.61	9.60	9.49	9.76	9.89	9.47	9.73	10.01	9.51	9.96	10.37
P-Value		*	*	*	*	*	*	*	*	*	*	*	*

**** Significant at P < 0.05***

3.2. Irrigation requirements for sugarcane under current and future conditions

Data in Table (4) show the irrigation requirement values under the current and different RCP scenarios in major areas of sugarcane production in the Middle and Upper Egypt governorates. The irrigation requirement values (cubic meter/feddan/season) for sugarcane under RCPs scenarios ranged between 8618.8m3/feddan (RCP3 at 2011-2040 in Menia using a gated pipe) to 16768 m3/feddan (RCP 8.5 at 2071-2100 in Aswan using flood irrigation). Concerning the RCPs scenarios and time series, Aswan governorate had the highest irrigation requirements, followed by Luxor and Qena. In contrast, Menia and Asyut had the lowest irrigation requirements for sugarcane. It could be concluded that the highest predicted irrigation requirements for sugarcane were found in the Upper Egypt governorates during different time series, while the lowest water requirement was found in Middle Egypt Governorate (Menia). Generally, the predicted irrigation requirement gradually increased with time series (2011-2040, 2041-2070 and 2071-2100) under different RCPs scenarios to reach the maximum predicted values during 2071–2100. The RCP 8.5 scenario had the highest irrigation requirements for sugarcane crop under the different governorates compared to the other RCPs scenarios.

Finally, flood irrigation (conventional irrigation method) had a higher irrigation requirement than the gated pipe irrigation system under all tested scenarios and time series. Irrigation requirement under gated pipe irrigation system was lower than flood irrigation system by about 28.56%. This result can be one of the adaptation options for the management of irrigation water for sugarcane under climate change conditions. These results agreed with Abdrabbo *et al.* (2013), Abdrabbo *et al.* (2015), and Farag *et al.* (2014). They reported that air temperature under climate change will be higher than current conditions and that irrigation requirements will be higher under different agro-ecological zones by uneven rates. Nour El-Din, (2013) concluded that low irrigation efficiency of conventional flood irrigation system increases the vulnerability of the water sector in Egypt because more water is needed to irrigate the cultivated crop. Under this study, using a gated pipe irrigation system is considered one of the solutions for low water use efficiency for the irrigation system. Abdrabbo *et al.* (2015) mentioned that ETo would be increased by 10-12% in the Nile Delta and will be increased by about 20% in

ISSN-Internet 2197-411x OLCL 862804632

Upper Egypt, meaning that Upper Egypt will be more vulnerable to the irrigation water availability (Farag *et al.* 2014). Irrigation performance in Egypt is the overall result of existing climatic conditions, irrigation systems and availability of investment (Hamdy, 2007).

The projected future temperature rises under climate change scenarios are likely to increase irrigation demands, thereby directly decreasing irrigation water use efficiency for all crops. The increase in the ETo in Egypt is projected to augment the national irrigation-demands by 10-20% during the 2100s. The availability of irrigation water is considered a regional problem under projected climate change. Climate assessment reports for the southern Africa region confirm that the region will become warmer and drier. The air temperature is predicted to increase by 2-5oC over coming decades (IPCC, 2007) and increasingly varied rainfall is anticipated, with the region becoming generally drier, especially in the east. The consequence of these combined impacts of climate change is expected to reduce the productivity of several crops (Lobell *et al.,* 2008).

3.3. Interpolation for irrigation water requirement

Table 4. Water requirements (cubic meter per feddan /season) for sugarcane in the Middle and Upper Egypt governorates using flood or gated pipe irrigation system under current and future conditions.

	Current	RCP3			RCP4.5			RCP 6			RCP 8.5		
	1971-2000	2011-2040	2041-2070	2071-2100	2011-2040	2041-2070	2071-2100	2011-2040	2041-2070	2071-2100	2011-2040	2041-2070	2071-2100
Menia													
flood irrigation	11500	12066	12257	12245	12085	12543	12804	12049	12474	13058	12135	12932	13843
Gated pipes	8214	8619	8755	8747	8632	8960	9146	8607	8910	9327	8668	9237	9888
P-Value		*	*	*	*	*	*	*	*	*	*	*	*
Asyut													
flood irrigation	11776	12301	12519	12489	12316	12817	13070	12268	12777	13335	12381	13246	14211
Gated pipes	8412	8786	8942	8921	8797	9155	9336	8763	9126	9525	8844	9461	10151
P-Value		*	*	*	*	*	*	*	*	*	*	*	*
Sohag													
flood irrigation	12455	12893	13067	13049	12895	13388	13530	12865	13331	13848	12975	13709	14585
Gated pipes	8897	9209	9334	9321	9211	9563	9665	9189	9522	9892	9268	9792	10418
P-Value		*	*	*	*	*	*	*	*	*	*	*	*
Qena													
flood irrigation	12826	13294	13553	13543	13329	13855	14138	13265	13754	14433	13381	14267	15025
Gated pipes	9162	9496	9681	9673	9521	9897	10099	9475	9824	10309	9558	10191	10732
P-Value		*	*	*	*	*	*	*	*	*	*	*	*
Luxor													
flood irrigation	13693	14276	14390	14390	14320	14678	14988	14242	14644	15104	14336	15076	15893
Gated pipes	9781	10197	10279	10279	10229	10484	10706	10173	10460	10788	10240	10769	11352
P-Value		*	*	*	*	*	*	*	*	*	*	*	*
Aswan													
flood irrigation	14955	15478	15696	15692	15502	15913	16114	15466	15877	16283	15540	16221	16769
Gated pipes	10682	11056	11212	11209	11073	11366	11510	11047	11340	11631	11100	11587	11978
P-Value		*	*	*	*	*	*	*	*	*	*	*	*

**** Significant at P < 0.05***

for the sugarcane

Figures 1, 2, 3 and 4 show the interpolation maps of total seasonal irrigation requirement (cubic meter per feddan) values for the major sugarcane production governorates in Middle and Upper Egypt. Each governorate was represented in the maps by using their corresponding coordinates. The interpolated maps created regions based on the similar irrigation requirement values; the same colour represents the value of irrigation requirement in the range of this region. Menia governorate had the lowest irrigation requirement value in comparison to the other locations, and it was recognised by the lighter colour. In contrast, Aswan governorate had the highest irrigation requirement values under current and RCPs scenarios. The interpolated maps confirmed that also the irrigation requirement values under different time series (2011-2040, 2041-2070 and 2071-2100) were higher than those values under the current situations. The interpolation indicated that the area of the dark colour (highest irrigation requirements) in Upper Egypt which contained Aswan and Luxor become larger under RCP 8.5 and under time series 2071-2100. This data confirm the finding above. The irrigation requirements in Aswan are higher than the other studied governorates, and RCP 8.5 had the highest water requirements in 2071-2100 time series. These results agreed with Farag *et al.* (2014) who reported that using interpolation technique helps demonstrate the climatic data under current conditions and climate change to help the decision-makers draw an accurate plan for future irrigation water management.

3.4. Fuel requirements for sugarcane crop under current and future conditions

Data in Table (5) show that the total fuel requirement for sugarcane will increase under all RCPs scenarios in comparison with the current conditions. Total fuel requirement in Upper Egypt governorates was higher than in Middle Egypt governorates. Fuel require-

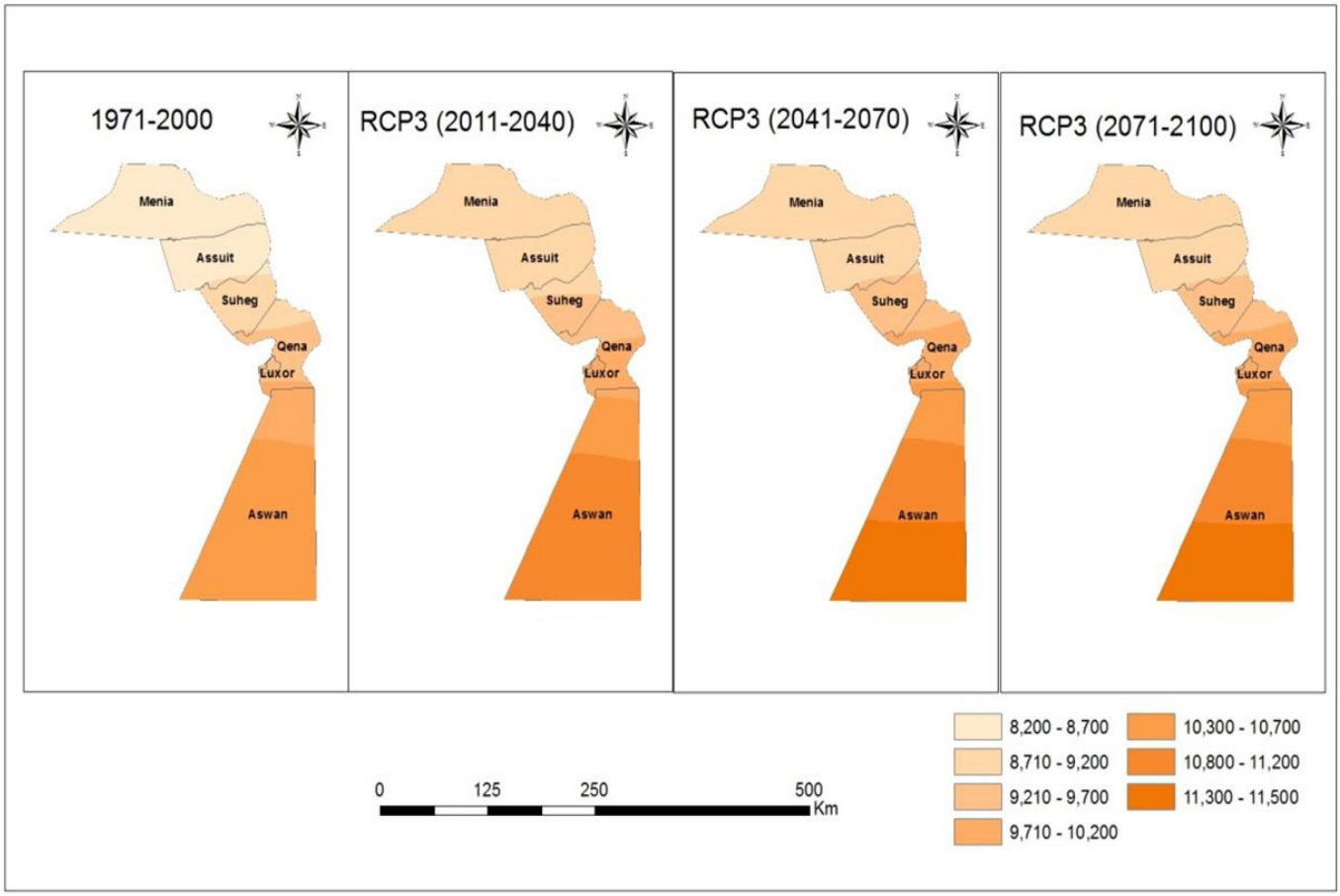


Fig. 1. Interpolation maps of total irrigation requirement values for sugarcane under current (1971 – 2000) and RCP3 conditions at 2011-2040, 2041-2070 and 2071 - 2100.

ISSN-Internet 2197-411x OLCL 862804632

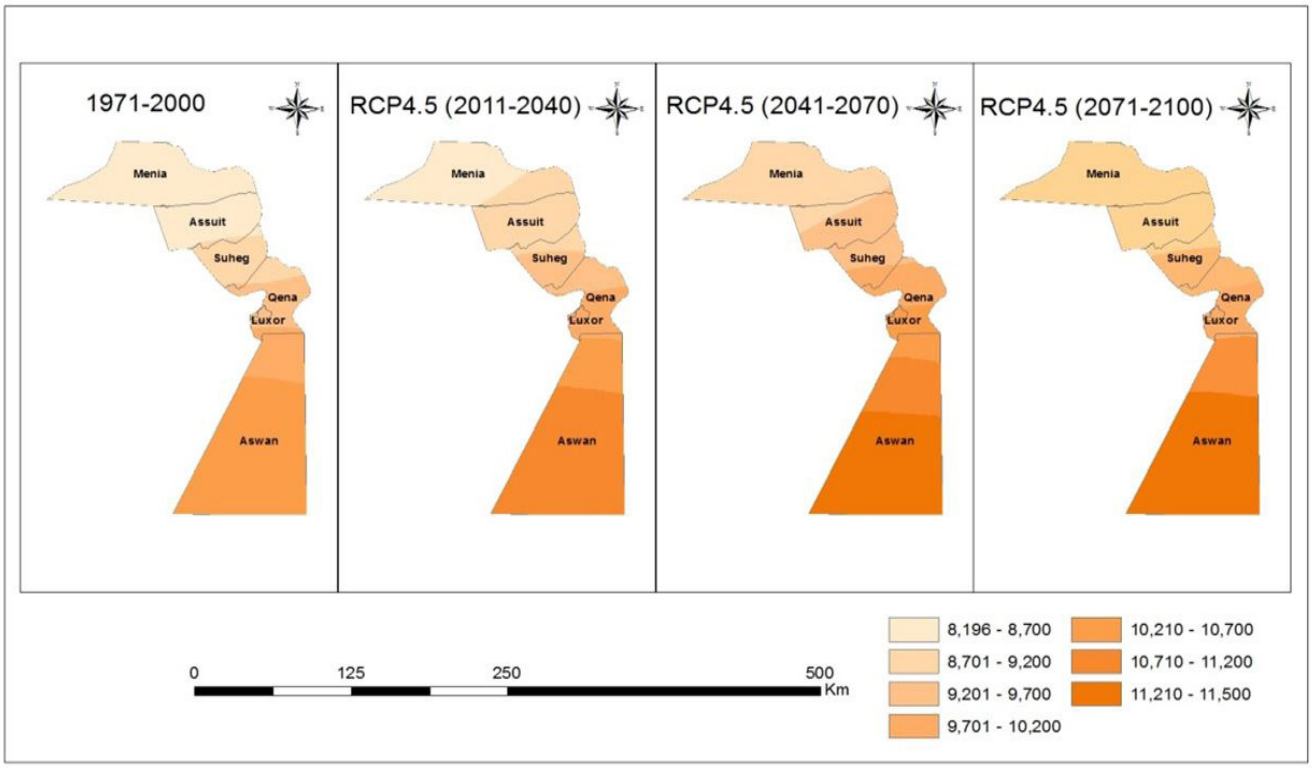


Fig. 2. Interpolation maps of total irrigation requirement values for sugarcane under the current (1971 – 2000) and RCP4.5 conditions at 2011-2040, 2041-2070 and 2071 - 2100.

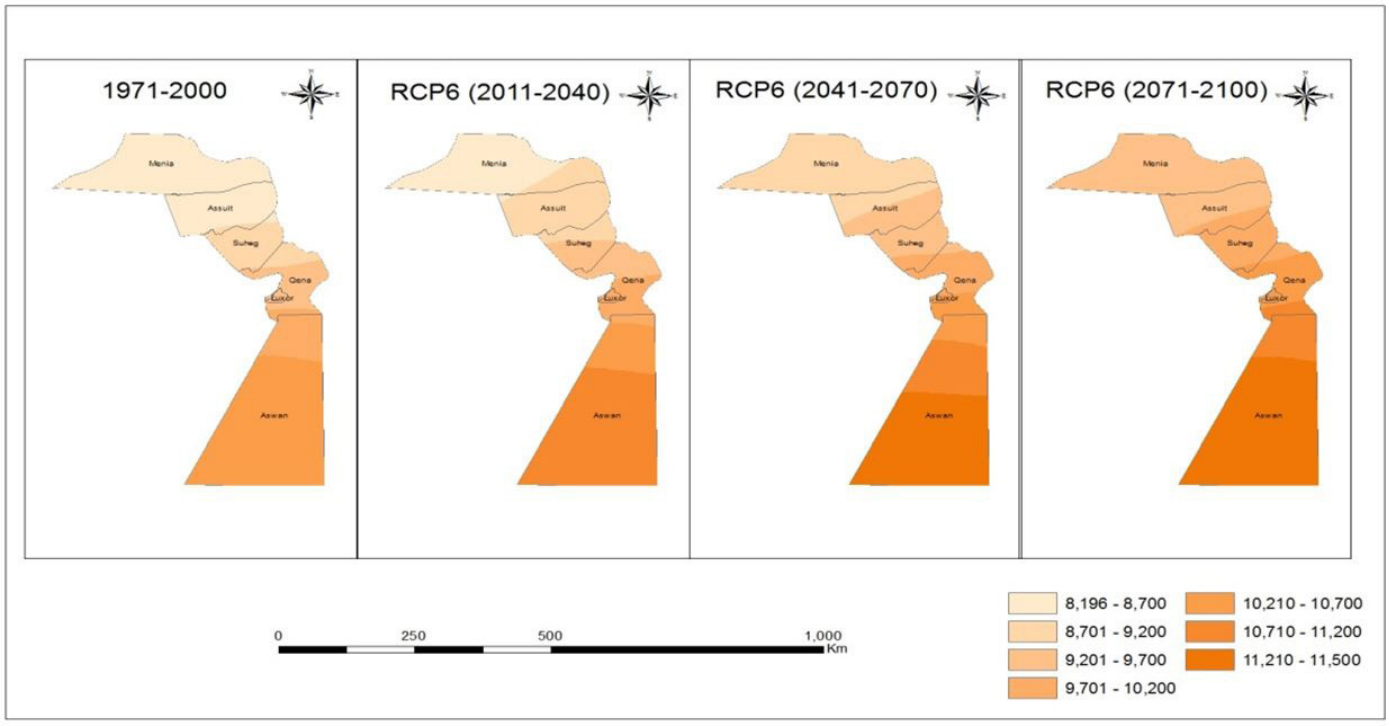


Fig. 3. Interpolation maps of total irrigation requirement values for sugarcane under the current (1971 – 2000) and RCP6 conditions at 2011-2040, 2041-2070 and 2071 - 2100.

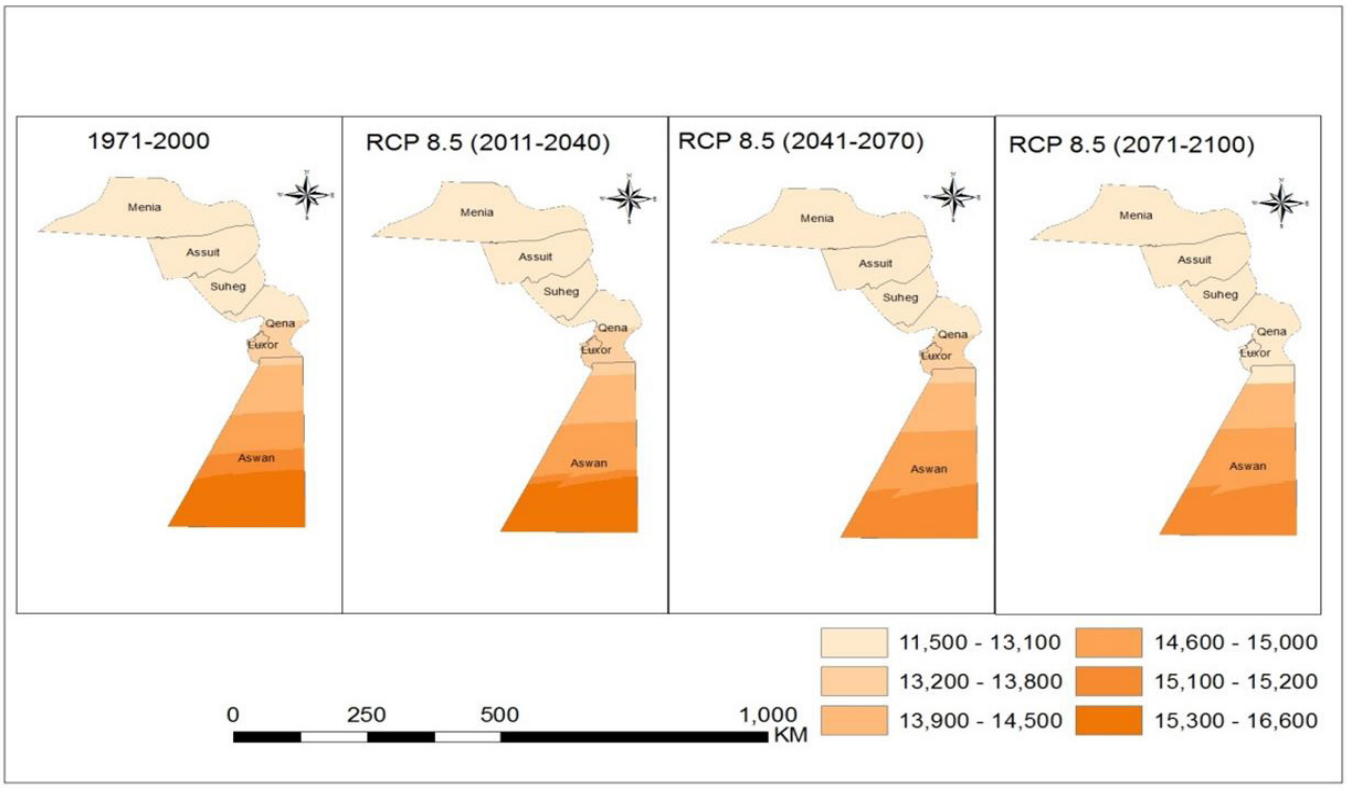


Fig. 4. Interpolation maps of total irrigation requirement values for sugarcane under the current (1971 – 2000) and RCP8.5 conditions at 2011-2040, 2041-2070 and 2071 - 2100.

ment increased under all RCPs scenarios as follow: RCP3 increase by 5%, RCP4.5 increase by 8%, RCP6 increase by 10% and RCP8.5 increase by 12% compared to the fuel requirements under current conditions. The highest fuel requirement was found under RCP8.5 at time series 2071–2100. This data agreed with Naohiro and Takahide (2015) and Henggeler *et al.* (2004), who concluded that the consumption of fuel would increase gradually with increasing air temperature and water consumption. The same authors added that the operation period would increase with increasing water need, and the fuel consumption will increase due to the impacts of high temperature under climate change based on climate change scenarios.

3.5. Cost of irrigation for sugarcane crop under current and future conditions

Data in Table (10) shows the seasonal water pumping cost (diesel cost + fixed cost + operating cost) of a flood irrigation system in the six governorates (Menia, Asyut, Sohag, Qena, Luxor and Aswan). The average water pumping costs were around 1571 L.E in the tested governorates under current conditions. The highest pumping cost was recorded in Aswan governorate followed by Luxor, Qena, Sohag, Asyut, and Menia (1826, 1671, 1566, 1520, 1438, and 1404 L.E, respectively). Also, Table (10) shows that the average cost (L.E/fed./season) of pumping water was around 1122 L.E under gated pipes system. Aswan governorate had the highest cost, followed by Luxor and Qena. Flood irrigation had higher pumping costs than gated pipe system by about 29% under current and future conditions. RCP8.5 scenarios had the highest pumping cost compared to the other RCP scenarios for all other time-series. Aswan governorate was highest in cost, followed by Luxor, Qena, Sohag, Asyut, and Menia (1735-1690-178-1696-1940-2047, respectively). The percentage of cost increase for RCP8.5 compared to current conditions for Aswan, Luxor, Qena, Sohag, Asyut, and Menia was 21%, 20%, 17%, 17% 16% and 12%, respectively.

It can be concluded that Aswan governorate had the highest pumping cost compared to the other governorates and thus higher production cost of sugarcane because of higher evapotranspiration than the other studied governorates. Regarding RCP scenarios,

ISSN-Internet 2197-411x OLCL 862804632

Table 5. Fuel requirements (liter of diesel per feddan /season) for sugarcane in the Middle and Upper Egypt governorates using flood or gated pipe irrigation system under current and future conditions.

	Current	RCP3			RCP4.5			RCP 6			RCP 8.5		
	1971-000	2011-2040	2041-2070	2071-2100	2011-2040	2041-2070	2071-2100	2011-2040	2041-2070	2071-2100	2011-2040	2041-2070	2071-2100
Menia													
flood irrigation	62.2	65.3	66.3	66.2	65.4	67.9	69.3	65.2	67.5	70.6	65.6	70.0	74.9
Gated pipes	44.4	46.6	47.4	47.3	46.7	48.5	49.5	46.6	48.2	50.5	46.9	50.0	53.5
Asyut													
flood irrigation	63.7	66.5	67.7	67.6	66.6	69.3	70.7	66.4	69.1	72.1	67.0	71.7	76.9
Gated pipes	45.5	47.5	48.4	48.3	47.6	49.5	50.5	47.4	49.4	51.5	47.8	51.2	54.9
Sohag													
flood irrigation	67.4	69.7	70.7	70.6	69.8	72.4	73.2	69.6	72.1	74.9	70.2	74.2	78.9
Gated pipes	48.1	49.8	50.5	50.4	49.8	51.7	52.3	49.7	51.5	53.5	50.1	53.0	56.4
Qena													
flood irrigation	69.4	71.9	73.3	73.3	72.1	75.0	76.5	71.8	74.4	78.1	72.4	77.2	81.3
Gated pipes	49.6	51.4	52.4	52.3	51.5	53.5	54.6	51.3	53.1	55.8	51.7	55.1	58.1
Luxor													
flood irrigation	74.1	77.2	77.9	77.9	77.5	79.4	81.1	77.0	79.2	81.7	77.6	81.6	86.0
Gated pipes	52.9	55.2	55.6	55.6	55.3	56.7	57.9	55.0	56.6	58.4	55.4	58.3	61.4
Aswan													
flood irrigation	80.9	83.7	84.9	84.9	83.9	86.1	87.2	83.7	85.9	88.1	84.1	87.8	90.7
Gated pipes	57.8	59.8	60.7	60.6	59.9	61.5	62.3	59.8	61.4	62.9	60.0	62.7	64.8

RCP8.5 had the highest pumping cost followed by RCP6 while the lowest pumping cost was estimated under current conditions. Moreover, the highest pumping cost was found under time series 2071–2100, followed by 2041-2070 while the lowest pumping cost under climate change was estimated under time series 2011-2040. This data agreed with Abdrabbo *et al.,* (2015), and Naohiro and Takahide (2015) who mentioned that the water requirements would increase under RCPs scenarios compared to the current conditions and then the cost of pumping water would increase gradually with the increasing water needs. The production of sugarcane in the upper region area faces many problems such as a conventional farm irrigation system with high irrigation quantities, the low income per unit area compared with cash crops, higher cost of fuel compared with 2012 season and competition between sugarcane and sugar beet (Farag *et al.,* 2017). Climate change issues will increase the challenges which impact the sustainable production of sugarcane in Upper Egypt (Abdrabbo *et al.,* 2015).

Cultivating alternative crops in such area is not an easy undertaking because there is a lack of knowledge in terms of good agricultural practices for such crops. The current work gives the decision-maker in the irrigation sector an accurate estimation of the irrigation requirements for sugarcane in the main cultivation area, which can help strategic measurements for future sugarcane cultivation. Alternatively, the sugarcane area from Aswan and Qena could be moved to Menia and Asyut, where there are lower evapotranspiration and lower irrigation water needs. On the other hand, Egypt already encounters a crisis related to the availability of freshwater due to linear increase in Egyptian population with limited irrigation water resources from the Nile River (Farag *et al.,* 2014). An issue which will become increasingly complicated with the construction of the Renascence Dam by Ethiopia (Nour El-Din, 2013). The decision-maker will need such results to determine the different available options to build strategic and contingent plans that take into consideration the socioeconomic aspect related to sugarcane production in Upper Egypt. Over the last ten years, there have been many efforts on to improve water use efficiency for this area through demonstration farms that use different irrigation methods such as gated pipes or drip irrigation system to enhance the productivity of unit of water (Osaman, 2002). The primary purpose of such strategy is to conserve a significant amount of water for cultivation area expansion and to enhance the food security of Egyptian people through proper irrigation water management as well as reduce the cost of production which means higher

profits for farmers (Abdel-Raheem *et al.,* 2016).

4. Summary and conclusion

The expected climate changes in Egypt, according to the RCP scenarios, will cause an increase in the ETo of all sugarcane cultivation areas. Irrigation requirements increased depending on climate change scenarios data. The expected climate changes in Egypt according to the RCP scenarios will also cause an increase in seasonal irrigation requirement for sugarcane under future climate change conditions. Using interpolated maps is an easy way to illustrate the irrigation requirements for sugarcane under climate changes for decision-makers to allow the building of future management plans. The economic study of the cost of irrigation concluded that fuel requirements would increase with increasing irrigation requirements under all RCP scenarios, which mean an increase in the cost of sugarcane production. Further studies are needed to study the effect of irrigation efficiencies on climate-proofing sugarcane production.

Acknowledgement:

We would like to acknowledge the Department of Science & Technology, Govt. of India and Academy of Scientific Research and Technology (ASRT) of Egypt for selecting the India – Egypt project proposal under joint Call (Title: Decision Support System to Estimate Water Requirements for the Major Crops) under which this research was performed.

Conflict of Interest

Table 6. The costs (L.E/feddan/season) of pumping water for sugarcane in the Middle and Upper Egypt governorates using flood or gated pipe irrigation system under current and future conditions.

Irrigation systems	flood irrigation system						gated pipes irrigation system					
Governorate	Menia	Asyut	Sohag	Qena	Luxor	Aswan	Menia	Asyut	Sohag	Qena	Luxor	Aswan
(1971-2000)												
Current conditions	1404	1438	1520	1566	1671	1826	1003	1027	1086	1118	1194	1304
(2011-2040)												
RCP3	1473	1502	1574	1623	1743	1889	1052	1073	1124	1159	1245	1350
differences %	**5%**	**4%**	**4%**	**4%**	**4%**	**3%**	**5%**	**4%**	**3%**	**4%**	**4%**	**4%**
RCP4.5	1475	1503	1574	1627	1748	1832	1054	1074	1124	1162	1249	1352
differences %	**5%**	**5%**	**4%**	**4%**	**5%**	**0%**	**5%**	**5%**	**3%**	**4%**	**5%**	**4%**
RCP6	1471	1498	1570	1619	1738	1888	1051	1070	1122	1157	1242	1349
differences %	**5%**	**4%**	**3%**	**3%**	**4%**	**3%**	**5%**	**4%**	**3%**	**3%**	**4%**	**3%**
RCP8.5	1481	1511	1584	1633	1750	1897	1058	1080	1131	1167	1250	1355
differences %	**5%**	**5%**	**4%**	**4%**	**5%**	**4%**	**5%**	**5%**	**4%**	**4%**	**5%**	**4%**
(2041-2070)												
RCP3	1496	1528	1595	1654	1757	1916	1069	1092	1139	1182	1255	1369
differences %	**7%**	**6%**	**5%**	**6%**	**5%**	**5%**	**7%**	**6%**	**5%**	**6%**	**5%**	**5%**
RCP4.5	1531	1565	1634	1691	1792	1942	1094	1118	1167	1208	1280	1387
differences %	**9%**	**9%**	**8%**	**8%**	**7%**	**6%**	**9%**	**9%**	**7%**	**8%**	**7%**	**6%**
RCP6	1523	1560	1627	1679	1788	1938	1088	1114	1162	1199	1277	1384
differences %	**8%**	**8%**	**7%**	**7%**	**7%**	**6%**	**8%**	**8%**	**7%**	**7%**	**7%**	**6%**
RCP8.5	1579	1617	1673	1742	1840	1980	1128	1155	1195	1244	1315	1414
differences %	**12%**	**12%**	**10%**	**11%**	**10%**	**8%**	**12%**	**12%**	**10%**	**11%**	**10%**	**8%**
(2071-2100)												
RCP3	1495	1525	1593	1653	1757	1916	1068	1089	1138	1181	1255	1368
differences %	**6%**	**6%**	**5%**	**6%**	**5%**	**5%**	**6%**	**6%**	**5%**	**6%**	**5%**	**5%**
RCP4.5	1563	1595	1652	1726	1830	1967	1116	1140	1180	1233	1307	1405
differences %	**11%**	**11%**	**9%**	**10%**	**10%**	**8%**	**11%**	**11%**	**8%**	**9%**	**9%**	**8%**
RCP6	1594	1628	1690	1762	1844	1988	1139	1163	1207	1258	1317	1420
differences %	**14%**	**13%**	**11%**	**13%**	**10%**	**9%**	**14%**	**13%**	**12%**	**14%**	**12%**	**9%**
RCP8.5	1690	1735	1780	1834	1940	2047	1207	1239	1272	1310	1386	1462
differences %	**20%**	**21%**	**17%**	**17%**	**16%**	**12%**	**20%**	**21%**	**17%**	**17%**	**16%**	**12%**

ISSN-Internet 2197-411x OLCL 862804632

The authors have no conflict of interest.

References

Abdel-Raheem, H. A., Tarek, A. A., & Yasser, A. A. (2016). Increasing economic returns for sugar cane crop by development irrigation system (gated pipes) in Egypt. Journal of American Science, 12(8):60-68.

Abdrabbo, M. A. A., Samiha, O., & Tahany, N. (2013). Modeling the Irrigation Schedule on Wheat under Climate Change Conditions. Nature and Science, 11: 10-18.

Abdrabbo, M. A., Farag, A. A., & El-Desokey, W. M. S. (2015). Implementing of RCPs Scenarios for the Prediction of Evapotranspiration in Egypt. International Journal of Plant & Soil Science, 6(1): 50-63.

Allen, R. G., Pereira, L. S., Raes, D., & Smith, M. (1998). Crop evapotranspiration: Guidelines for computing crop requirements. Irrigation and Drainage Paper No. 56, FAO, Rome, Italy.

Chandiposha, M. (2013). Potential impact of climate change in sugarcane and mitigation strategies in Zimbabwe. Afr. J. Agric. Res, 8(23): 2814-2818.

ESRI. (2012). ArcGIS Geostatistical Analysis. Tutorial (ArcGIS ®10.1). Printed in the United States of America.

Farag, A. A., Abdrabbo, M. A. A., Ahmed, M. S. M. (2014). GIS Tool for Distribution Reference Evapotranspiration under Climate Change in Egypt. ; International Journal of Plant & Soil Science, 3(6): 575-588.

Farag, A. A., Abdrabbo, M. A., M. and Gad EL-Moula M. H. (2015). Water requirements for potato production under climate change. Global Journal for Advanced Research, 2(9): 1371-1389.

Farag, A. A., Abdrabbo, M. A., Taher, M. S., Farag, H. A., Rasha, M. A., & Radwan, H. A. (2017). Comparative Study Of The Production Of Sugar Crops Under Limited Water. Egyptian J. Agriculture Res, 95: 87-96.

Goovaerts, P. (2000). Geostatistical approaches for incorporating elevation into the spatial interpolation of rainfall. Journal of Hydrology 228: 113-129.

Hamdy A. (2007). Water use efficiency in irrigated agriculture: an analytical review. Proceedings of the fourth WASAMED workshop, Amman, Jordan, Option Mediterranean Series, CIHAM, B. n. 57. p. 9-19

Hanafy, M., Mahrous, A., & El Garib, M. Z. (2008). Water requirements for irrigated sugarcane under trickle irrigation systems. Misr J. Ag. Eng., 25(4): 1343-1357.

Henggeler, J., Henry, D., & Kenny, N. C. (2004). Measuring Diesel Fuel Consumption to Estimate Engine Efficiency, University of Missouri. Retrieved from: https://www.researchgate.net/profile/Arvind_Singh56/post/How_to_measure_the_efficiency_of_diesel_engine/attachment/59d6407179197b807799ca7c/AS%3A431123860856833%401479799346198/download/1.pdf

IPCC. (2013): Climate Change 2013: The Physical Science Basis. Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp.

IPCC. (2007). Climate change 2007: the physical science basis. Summary for policymakers. Contribution of working group I and II to the third assessment report of the IPCC. IPCC Secretariat, Geneva, Switzerland.

Knox, J. W., Rodríguez Díaz, J. A., Nixon, D. J., & Mkhwanazi, M. (2010). A preliminary assessment of climate change impacts on sugarcane in Swaziland. Agricultural Systems, 103(2): 63-72.

Krol, M. S., & Bronstert, A. (2007). Regional integrated modeling of climate change impacts on natural resources and resource usage in semi-arid Northeast Brazil. Environ. Model. Softw., 22(2): 259-268.

Lobell, D.B., Burke, M.B., Tebaldi, C., Mastrandrea, M.D., Falcon, W.P., & Naylor, R.L. (2008). Prioritising climate change adaptation needs for food security in 2030. Science, 319: 607-610.

El-Kholi, M. M. A. (2008). Sugar Crops Research

Institute, Giza (Egypt): A Profile. Sugar Tech, 10(3): 189-196.

Naohiro, A., & Takahide, K. (2015). Development of high efficiency water pump. Honda R & D technical review: Vol: 27 (1): pp. 142.

Nour El-Din, M. (2013). Proposed Climate Change Adaptation Strategy for the Ministry of Water Resources & Irrigation in Egypt. Retrieved from: http://www.eeaa.gov.eg/English/reports/CCRMP/7.%20CC%20Water%20Strategy/CC%20Final%20Submitted%208-March%202013%20AdptStrtgy.pdf

Omar, S. R., & Tate, B. (2019). Increasing Sugar Supply on Expanded Beet Production. USDA-GAIN Report Number: 19006. pp.9. Retrieved from: https://apps.fas.usda.gov/newgainapi/api/report/downloadreportbyfilename?filename=Sugar%20Annual_Cairo_Egypt_4-15-2019.pdf

Osaman, H.E. (2002). Evaluation of surface irrigation using gated pipes techniques in field crops and old horticultural farm. Annals Agric. Sci., 47(2):461-475.

Raouf, F.K. (1996). Economic Incentives to Promote the Abatement of Nile Pollution. Berkeley: The Sixth Annual Meeting of the International Association for the Study of Common.

Ritchie, J. & Dowlatabadi, H. (2017). Why do climate change scenarios return to coal? Energy, 140: 1276–91.

SAS. (2000). Statistical Analysis System, SAS User's Guide: Statistics. SAS Institute Inc. Editors, Cary, NC. 2000.

Smith, M., Allen, R., Pereira, L. (1996). Proceeding of the International Conference of "Evapotranspiration and Irrigation scheduling", American Society of Agricultural Engineers, 3-6 November, Texas, USA

Thompson, J., Curley, R., & Knutson, J. (2002). Reducing Water Pumping Costs, Agricultural Engineering Dept. UC Davis One Shields Ave., Davis, CA.

Elasraag, Y. H. (2019). Economic Analysis of Sugarcane and Sugar Beet in Egypt. Zagazig J Agric Res, 46 (1): 209-215.

ISSN-Internet 2197-411x OLCL 862804632

Future of Food: Journal on Food, Agriculture and Society
9 (2) May 2021

Determination of the factors affecting the amount of food waste generated from households in Turkey

Ayse Nur Songur Bozdag[1*], Funda Pinar Cakiroglu[2]

[1]Department of Nutrition and Dietetics, University of Izmir Kâtip Celebi, Izmir, Turkey
[2]Department of Nutrition and Dietetics, University of Ankara, Ankara, Turkey

* Corresponding author: dytnur91@gmail.com

Data of the article

First received : 25 September 2020| Last revision received : 16 December 2020
Accepted : 05 January 2021 | Published online : 12 February 2021
DOI : 10.17170/kobra-202011192214

Keywords

Food wastage; sociodemographic; shopping; planning.

This study aims to put forward and discuss the analysis results of various factors on the creation of food waste from households. An online survey application was used, and 1,488 individuals participated in the study. Of the participants, 32.9% stated that they produce 0-1 kg of food waste. The main reasons for food waste were found to be mouldy food, food left in the refrigerator for too long and the date expiration of food. There was a significant negative association between the amount of food waste in households and age, living place, control of refrigerator/storage cabinet, preparation of a shopping list, and the determination of time for food to be cooked and the frequency of preparing meals with fresh foods. On the other hand, there was a significant positive association between the amount of food waste in households and household average food consumption per week, the number of women living at home, frequency of food shopping, buying food that is not needed when shopping, frequency of noticing that you forgot to use food once you used it and stored in the refrigerator/storage cabinet, frequency of ordering food at home, frequency of food preparation with prepared food products, and frequency of thinking that portion size of the dish was large when cooking or serving a meal. Also, it has been found that there is a significant relationship between the amount of food waste and one's profession, shopping place, and the feeling of guilt when throwing food away ($p<0.05$). Based on the study results, to prevent waste generation behaviours of individuals, effective initiatives should be carried out through awareness campaigns in various areas.

1. Introduction

Food loss and waste are critical sustainability issues that should be handled due to the economic, environmental and social impacts. Food losses are associated with the decrease in the amount of edible food during production, post-harvest and processing stages. In contrast, food wastes refer to the foods which are lost at the retailer and consumer level (Parfitt *et al.,* 2010). According to a report by the United Nations Environment Programme (UNEP) and the World Resources Institute (WRI), one-third of the foods produced around the world is wasted or discarded on an annual basis, half of which is generated at the household level (especially in developed countries) (Jorissen *et al.,* 2015).

The amount of food waste generated by households is estimated to be more than 50.0% of the total food waste in Europe (Kummu *et al.,* 2012), and up to 60.0% of the total food waste occurs in the USA (Griffin *et al.,* 2009). Researches in England have revealed that the amount of food and drink wasted at the household level is approximately 22.0% of all foods and drinks

purchased (330 kg per household annually). More so, 65.0% of such wastes (215 kg per household annually) are edible before they discarded (WRAP, 2009).

Households represent the last point of the profit-driven food supply chain and a complex structure of food management behaviours (Stancu *et al.,* 2016). A better understanding of such behaviours can be used to maximise food-management efficiency in households and to minimise food wastes. Previous studies on the factors affecting food waste in households emphasise that the generation of food waste is a complex issue affected by many factors such as sociodemographic features (age, gender, income, household size, etc.), shopping behaviours, poor cooking skills, packaging failures, medical misunderstandings to waste foods, and cultural differences (Aschemann-Witzel *et al.,* 2015; Evans, 2012; Koivupuro *et al.,* 2012; Monier *et al.,* 2010; Sharp *et al.,* 2010; Stancu et al, 2016; Stefan *et al.,* 2013).

Sociodemographic factors are among the key factors affecting the generation of food waste from households. While research shows that women generate more food waste than men, there are also some studies showing that men generate more food waste (Barr, 2007; Koivupuro *et al.,* 2012; Secondi *et al.,* 2015; Visschers *et al.,* 2016). Age is considered an important factor in the generation of food waste, and it is suggested that young people tend to generate more waste (Quested *et al.,* 2013; Visschers *et al.,* 2016). Household size and type are pointed out as another critical factor in the generation of food waste (Koivupuro *et al.,* 2012; Parizeau *et al.,* 2015; Tucker & Farrelly, 2016; Visschers *et al.,* 2016). It has been observed that bigger households with children generate more food waste while the amount of food waste per person is higher in smaller households. There are some inconsistencies between results showing the impact of household income and residential area on the generation of food waste (Ganglbauer *et al.,* 2013; Jorissen *et al.,* 2015; Koivupuro *et al.,* 2012; Mattar *et al.,* 2018; Neff *et al.,* 2015; Secondi *et al.,* 2015). While an enhanced level of education is correlated with a reduced generation of food waste (Abdelradi, 2018; Qi & Roe, 2016), research has also suggested that people with a lower level of education might generate less food waste (Monier *et al.,* 2010; Secondi *et al.,* 2015). It has been suggested that occupation is also among the factors affecting food waste generation (Mattar *et al.,* 2018; Qi & Roe, 2016).

The planning and creation of a shopping list are useful in the minimisation of food waste at the household level (Sharp *et al.,* 2010; Stefan *et al.,* 2013). Moreover, it is known that people who fall under the influence of special offers while shopping, generate more food waste (Mattar *et al.,* 2018), and that the foods which are purchased, placed in the refrigerator and forgotten also lead to food waste (Graham- Rowe *et al.,* 2014, Koivupuro *et al.,* 2012; Ponis *et al.,* 2017). The frequency of shopping also affects the amount of food waste. Jorissen et al. (2015) have found that food waste decreases as the frequency of shopping increases in Germany, but not in Italy. It has been established that there is a direct proportion between the weekly cost of food shopping and the amount of food waste (Gaiani *et al.,* 2018). Furthermore; it is considered that foods with bigger package sizes are associated with higher amounts of food waste (Williams *et al.,* 2012).

Williams et al. (2012) observed that approximately 40.0% of food waste from households in England is generated because more meals are cooked, prepared and served than are consumable. Lyndhurst et al. (2007) determined that behaviours such as poor cooking plans, changes in cooking plans, lack of desire to eat leftovers and not knowing what to do with them also lead to the generation of food waste by households.

The growing number of individuals who are concerned or feel guilty about food waste shows an intention to minimise such wastes, which is relevant for the minimisation of food waste (Mondejar- Jimenez *et al.,* 2016; Neff *et al.,* 2015; Principato *et al.,* 2015; Stancu *et al.,* 2016; Stefan *et al.,* 2013; Qi & Roe, 2016; Quested *et al.,* 2013).

It is observed that various sociodemographic, behaviour, and attitude factors are effective in the generation of food wastes, which have unfavourable economic, environmental, and social impacts at the household level. This study aims to establish the factors affecting the generation of food waste at the household level in Turkey and to provide preventive solutions.

2. Material and methods

2.1. Participants and data collection

ISSN-Internet 2197-411x OLCL 862804632

The research was conducted between November-December 2018. In consequence of the study, 1,564 individuals living in the country were reached. Individuals who failed to indicate the average monthly amount of food waste, an explanation, the types of raw and cooked foods discarded most frequently, and those who provided imperfect sociodemographic information, were excluded from the study during analysis. The analyses were conducted with 1,488 individuals. The survey form of the research was sent to people through the researcher's social media accounts. The study was conducted voluntarily, and the participants were not provided with an incentive to participate in the study.

2.2. Questionnaire development

The questionnaire was developed upon assessment of similar studies found in literature (Aschemann-Witzel *et al.,* 2017a; Aschemann-Witzel *et al.,* 2017b; Gaiani *et al.,* 2018; Janssen *et al.,* 2017; Mallinson *et al.,* 2016; Ponis *et al.,* 2017; Szabó-Bódi *et al.,* 2018) and sent to participants. Each questionnaire was comprised of four sections:

2.2.1. Section #1: Sociodemographic features

This section included multiple-choice questions inquiring on the participants' age, gender, level of education, occupation, marital status, average monthly household income and average weekly household food expenditure. Open-ended questions asked about the residential area and those living in the household, including, number of individuals, children aged 6-11, and women.

2.2.2. Section #2: Features and behaviours for food shopping

Participants were given multiple-choice questions about the person who plans and performs the food shopping in their homes, the frequency of food shopping (once a month, once a week, twice a week, every day etc.), where food shopping is generally performed, the means of food shopping, pre-food shopping processes (checking the refrigerator/store cupboard, creating a shopping list), points paid attention to while purchasing food, and tendencies to purchase any unnecessary products or fall under the influence of special offers.

2.2.3. Section #3: Features and behaviours for preparing and consuming food at home

Multiple-choice questions were asked to the participants regarding whether they like spending time in the kitchen preparing/cooking meals, evaluation of their cooking skills, the time of determination of the food to be cooked at home, the frequency of take-home foods (never, 1-2 times a week, 3-4 times a week etc.), the frequency of preparing meals with fresh foods and trying new recipes in the kitchen (always, very often, sometimes etc.), consideration of the serving size as large while cooking and serving any meal, the frequency of cooking, ordering a meal, eating any previously-cooked meal and enjoying meals with friends/guests at home in a week (never, 1-2 times a week, 3-4 times a week etc.).

2.2.4. Section #4: Information, attitudes and behaviours for food waste

Questions were asked about the raw and cooked foods discarded most frequently, reasons thereof, estimated monthly average of food waste amount, feeling of guilt for wasted foods, suggestions to minimise food waste, and level of awareness and willingness on the initiatives intending to minimise the food waste. While the questions regarding the raw and cooked foods discarded most frequently were open-ended, all others were multiple choice.

2.3. Data analyses

The factors that potentially affect the amount of food waste were used variably in the study. These factors included sociodemographic features such as age, income and residential area, shopping features (frequency and points of shopping), features for cooking and consuming meals (frequency of cooking at home, cooking skills) and feeling of guilt for discarding foods.

SPSS 20 software was employed for statistical analysis of the data obtained in the study. Categoric data were presented in figure-percentage. A Multiple Response Set was created while assessing the questions with multiple responses. Chi-square test and Fisher's exact test were used to compare the classified data. Pearson correlation analysis was conducted to assess the relations between the variables. The results were assessed

in a confidence interval of 95%, and a significance level of $p<0.05$.

3. Result

Information on the sociodemographic characteristics of the participants shown in Table 1.

More than half of the participants reported "Myself" as the person who food shops (62.1%) and plans food shopping (53.4%). The frequency of food shopping was reported as "two times a week" on a maximum

Table 1. Socio-demographic features of the participants

	n	%
Age		
Aged 19-30	**796**	**53.5**
Aged 31-40	537	36.1
Aged 41-50	123	8.3
Aged 51 and above	32	2.1
Gender		
Women	**1408**	**94.6**
Men	80	5.4
Level of education		
Literate	4	0.3
Secondary school-primary school graduate	19	1.3
High school graduate	151	10.1
Collage-university graduate	**990**	**66.5**
Post-graduate	**324**	**21.8**
Occupation		
Housewife	265	17.8
Government officer	**485**	**32.6**
Worker	21	1.4
Self-employed	82	5.5
Unemployed	91	6.1
Retired	18	1.2
Private Sector	288	19.4
Student	146	9.8
Academician	92	6.2
Marital Status		
Married	**1047**	**70.4**
Single	441	29.6
Average monthly household income		
TRY 500.00 and below ($ 90.0) and below	101	6.8
TRY 500.00-TRY 1,000.00 ($ 91.00 - $ 180.00)	40	2.7
TRY 1,000.00 – TRY 1,500.00 ($ 181.00 - $ 270.00)	40	2.7
TRY 1,500.00 – TRY 2,000.00 ($ 271.00 - $ 360.00)	97	6.5
TRY 2,000.00 – TRY 3,000.00 ($ 361.00 – $ 540.00)	182	12.2
TRY 3,000.00 – TRY 4,000.00 ($ 541.00 - $ 720.00)	245	16.5
TRY 4,000.00 – TRY 5,000.00 ($ 721.00 - $ 900.00)	219	14.7
TRY 5,000.00 and above ($ 901.00 and above)	**564**	**37.9**
Average weekly household food expenditure		

ISSN-Internet 2197-411x OLCL 862804632

Continue Table 1. Socio-demographic features of the participants

Average weekly household food expenditure		
Below TRY 50.00 (below $ 9.00)	48	3.2
TRY 50.00 – TRY 100.00 ($ 9.00 - $ 18.00)	315	21.2
TRY 100.00 – TRY 200.00 ($ 19.00 - $ 36.00)	**502**	**33.7**
TRY 200.00 – TRY 300.00 ($ 37.00 - $54.00)	353	23.7
TRY 300.00 and above ($ 55.00 and above)	227	15.3
Unknown	43	2.9
Number of individuals living in the household		
1	94	6.3
2	372	25.0
3	**519**	**34.9**
4	359	24.1
5 and above	144	9.7
Number of children aged 6-11 living in the household		
0	**1237**	**83.1**
1	202	9.9
2 and above	49	3.0
Number of women living in the household		
0	6	0.4
1	**1049**	**70.5**
2	305	20.5
3 and above	128	8.6
Residential area		
Metropolitan	**1130**	**75.9**
City	285	19.2
Town	57	3.8
Village	16	1.1

basis (33.9%). The frequent points of shopping were shown to be "supermarkets" (41.7%) and "markets" (37.0%), and 53.6% of them do so by "motor vehicles (car, motorcycle, taxi)". Before going for food shopping 49.5% of them "always" check the refrigerator/store cupboard, 34.2% of them "always" create a shopping list, while 33.1% of them "sometimes" forget the foods they have purchased in the refrigerator/storage cupboard (Table 2).

The participants' main consideration points while purchasing foods are as follows; whether the product meets the "price-quality balance", "high-quality" and "label info". A great majority of the participants (82.9%) check the "expiration date" of the product while food shopping. The ones who "sometimes" purchase any unnecessary products during shopping correspond to 48.7% of the participants, and 86.2% of the participants fall under the influence of special offers (discounts, multiple packages) during shopping (Table 2).

More than half of the participants (59.2%) have indicated that they like spending time in the kitchen preparing/cooking meals, and 57.9% of them have indicated that their meal preparation/cooking skills are "good". In comparison, 56.7% of them have indicated that they determine what food will be cooked "on the day of cooking". Of the participants, 59.9% indicated that they "quite often" prepare meals with fresh foods while 40.7% of them indicated that they "rarely" prepare meals with take-home foods (canned, frozen foods). 55.9% of the participants have indicated that they "sometimes" try new recipes in the kitchen, while 46.2% of them have indicated that they "sometimes" consider the serving size as large while cooking or

serving any meal. 46.6% of the participants cook meals "5-7 times" a week, 56.1% of them "never" order any meal to their homes. Overall, 62.8% of them reported eating any previously-cooked meal "1-2 times" a week, and 54.7% of them enjoy their meals with their friends/guests "1-2 times" a week (Table 3).

Table 2. Information to food shopping

	n	%
The person planning the food shopping *		
Myself	1328	62.1
My wife/husband	491	23.0
Family Elders	294	13.8
Brother/Sister	15	0.7
Other (Assistant, etc.)	7	0.3
Children	2	0.1
The person going to food shopping *		
Myself	1277	53.4
My wife/husband	783	32.8
Family Elders	297	12.4
Brother/Sister	21	0.9
Other (Assistant, etc.)	10	0.4
Children	2	0.1
Frequency of food shopping		
Everyday	99	6.7
Every other day	286	19.2
Twice a week	505	33.9
Once a week	433	29.1
Biweekly	112	7.5
Once in a month	53	3.6
Place of food shopping		
Supermarkets	621	41.7
Markets	550	37.0
Small shops (bakery, butcher, etc.)	124	8.3
Bazaar	114	7.7
Direct from the manufacturer	56	3.8
Online	19	1.2
Wholesale markets	4	0.3

ISSN-Internet 2197-411x OLCL 862804632

Continue Table 2. Information to food shopping

	n	%
The way to go food shopping		
Motor vehicles (car, motorcycle, taxi)	797	53.6
On foot	639	42.9
Public transport	33	2.2
Home delivery (Online)	10	0.7
Bicycle	9	0.6
Checking the refrigerator / store cupboard before food shopping		
Always	737	49.5
Very often	481	32.3
Sometimes	222	14.9
Rarely	39	2.6
Never	9	0.7
Creating a shopping / needs list before food shopping		
Always	509	34.2
Very often	421	28.3
Sometimes	370	24.9
Rarely	122	8.2
Never	66	4.4
Forgetting purchased food in the refrigerator / store cupboard		
Always	31	2.1
Very often	133	8.9
Sometimes	493	33.1
Rarely	731	49.1
Never	100	6.7
Main points considered when buying food *		
Meeting the price-quality balance	1212	25.5
Being high-quality	864	18.1
Label info	746	15.7
Being organic	705	14.8
Being cheap	591	12.4
Being an ordinary product	395	8.3
Packaging feature	178	3.7
Having new features	43	0.9

Continue Table 2. Information to food shopping

	n	%
Being domestic production	13	0.3
Not close to the expiration date	8	0.2
Being expensive	4	0.1
Having halal certificate	2	0.05
Checking the expiration date when food shopping		
Yes	1233	82.9
Sometimes	244	16.4
No	11	0.7
Buying the unnecessary product while food shopping		
Always	20	1,3
Very often	133	8,9
Sometimes	724	48,7
Rarely	547	36,8
Never	64	4,3
Special offers positive affect purchasing status when food shopping		
Yes	557	37.4
Sometimes	725	48.8
No	206	13.8

*Multiple responses were provided.

Table 3. Respondents' answers on meal preparation and cooking at home

	n	%
Liking spending time in the kitchen preparing/cooking meals		
Yes, I like	881	59.2
Sometimes I like	440	29.6
No, I do not like	167	11.2
The skill to meal preparation/cooking		
Very bad	7	0.6
Bad	17	1.1
Middle	411	27.6

ISSN-Internet 2197-411x OLCL 862804632

Continue Table 3. Respondents' answers on meal preparation and cooking at home

	n	%
Bad	17	1.1
Middle	411	27.6
Good	862	57.9
Excellent	191	12.8
The time to determine the food to be cooked at home		
Just before cooking	7	0.6
On the day I cook	843	56.7
One or a few days before cooking	543	36.5
At the beginning of the week	92	6.2
At the beginning of the month	3	0.2
Frequency of preparing meals with fresh foods		
Always	437	29.4
Very often	892	59.9
Sometimes	148	9.9
Rarely	10	0.7
Never	1	0.1
Frequency of food preparation with take-home food products (canned, frozen foods, etc.)		
Always	8	0.5
Very often	124	8.3
Sometimes	539	36.2
Rarely	605	40.7
Never	212	14.3
Frequency of trying new recipes		
Always	54	3.6
Very often	320	21.5
Sometimes	832	55.9
Rarely	260	17.5
Never	22	1.5
Frequency to think about the big portion size of a meal when cooking or serving		
Always	83	5.6
Very often	253	17.0
Sometimes	687	46.2
Rarely	356	23.9
Never	109	7.3
The frequency of cooking at home in a week		
5-7 times	693	46.6
3-4 times	620	41.7
1-2 times	165	11.1
Never	10	0.6

Continue Table 3. Respondents' answers on meal preparation and cooking at home

	n	%
The frequency of cooking at home in a week		
5-7 times	693	46.6
3-4 times	620	41.7
1-2 times	165	11.1
Never	10	0.6
The frequency of ordering food to home within a week		
5-7 times	5	0.3
3-4 times	55	3.7
1-2 times	593	39.9
Never	835	56.1
Frequency of eating previously cooked food at home within a week		
5-7 times	37	2.4
3-4 times	458	30.8
1-2 times	934	62.8
Never	59	4.0
Frequency of eating with friends/guests at home within a week		
5-7 times	9	0.6
3-4 times	46	3.1
1-2 times	814	54.7
Never	619	41.6

The estimated amounts of monthly foods discarded in the households by participants are provided in Figure 1.

The raw foods discarded from households most frequently were vegetables (35.7%), salad ingredients (greens) (33.0%), and fruits (17.8%) (Figure 2).

The cooked foods discarded by households most frequently were pasta, rice, bulgur (24.1%), leftovers (15.0%) and soups (11.4%) (Figure 3).

Results reveal that the main reasons for discarding foods from households were as follows: "expired products", "formation of mould, etc. on the food" and "storage of food for an excessive period in the refrigerator" (Table 4).

The question of "Do you feel guilty for discarded foods?" was responded with "Yes" by 91.5% of the participants, "no" by 0.7% of them, and "sometimes" by 7.8% of them. Where the participants were requested to provide suggestions to minimise food waste, the most common suggestions were as follows: "Provision of more information to people about the environmental impacts of food waste", "creation of recipes for reuse of any leftover meals/foods", "raising the level of awareness of people on the monetary value of food waste", "raising the level of awareness of people on the social value of food waste", "making serving sizes smaller" and "purchase of smaller packages while purchasing packaged foods".

After analysis of the levels of food waste awareness and willingness of the participants, 63.0% of them have indicated that they have read, seen or heard something about this matter in the last six months. Still, only 11.6% of them know about either a practice, initiative or campaign to minimise the food waste generated across the country or in cities in which they live. In

ISSN-Internet 2197-411x OLCL 862804632

total, 93.2% of the participants have indicated that they want to be provided with more information on how to prevent food waste, and 76.0% of them have indicated that they want to spend extra time and effort to eliminate any food waste. Besides, 64.8% of them have indicated that they would like to take part in any practice, initiative, campaign or other programs to minimise the food waste generated by households.

Table 5 shows the correlations between some factors considered to affect the generation of food waste and amounts of food waste generated by households. As the factors of age and urbanisation rate increased, the amount of food waste decreased ($p<0.05$). Similarly, when participants engaged in pre-shopping processes such as checking the refrigerator/supply cabinet or preparing a shopping list, prepared meals with fresh foods, and conducted menu planning in advance, the amount of food waste also decreased ($p <0.05$). On the contrary, when factors such as weekly food expenditure, the number of women living in the household, and the frequency of food shopping increased, food waste increased ($p<0.05$). Results also revealed that food waste increased as the following behaviours increased ($p<0.05$): purchases of unnecessary products during food shopping; purchase of foods stored and forgotten (in refrigerator/store cupboard,) after single-use; meals bought for home delivery; meals prepared with take-home foods (canned, frozen products); frequency of considering the serving size of any meal as big while cooking or serving such a meal.

Besides the preceding, the average monthly amount of food waste generated by households also varies depending on an individual's occupation, common points of shopping, and whether they feel guilty for discarding foods ($p<0.05$). While most housewives, workers, self-employed persons, unemployed persons, retired persons, students and academics indicate their average monthly food waste amount as 0-1 kg, government officers and private sector employees indicate amounts between 1-3 kg. Nearly half of those shopping in supermarkets indicated that they generate 1-3 kg of food waste, while most of those shopping in small shops (butcher's shop, bakery, etc.), markets, direct producers, online shops, bazaars or retail markets indicated generating 0-1 kg of food waste. When respondents were asked about whether they feel guilty for discarding foods, 37.8% of those who responded "Yes" have indicated that they generate food wastes of 0-1 kg. Whereas 50.0% of those who responded "No" and 33.0% of those who responded "Sometimes" indicated that they generate 1-3 kg of food waste.

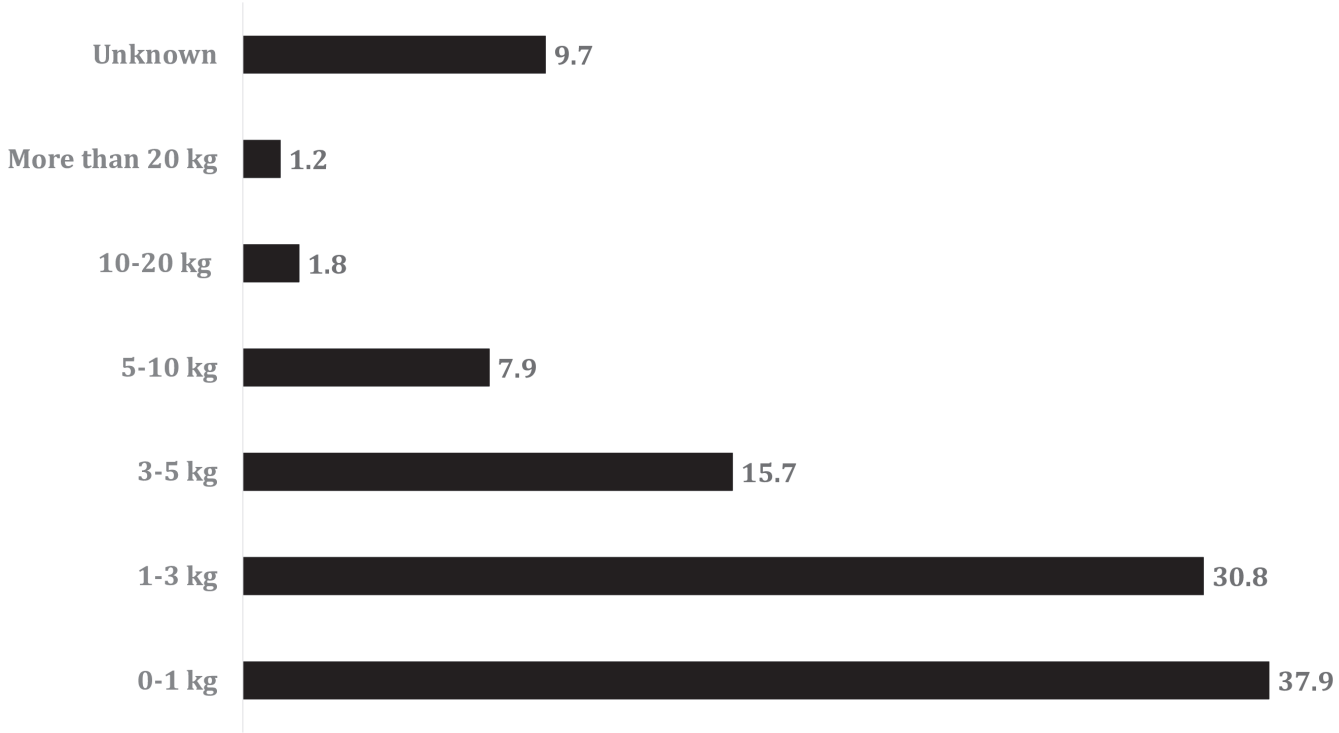


Figure 1. Amount of food discarded by households in a month (%)

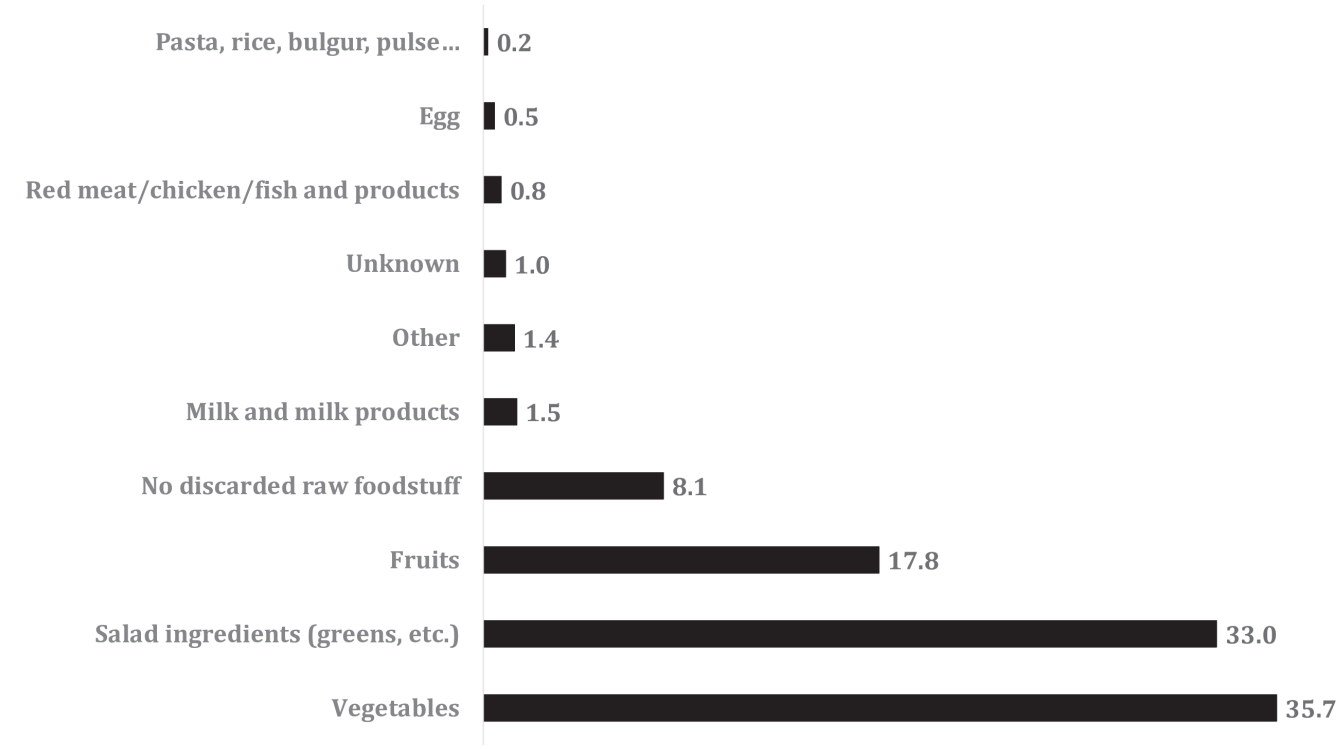


Figure 2. Raw foods discarded most frequently (%)

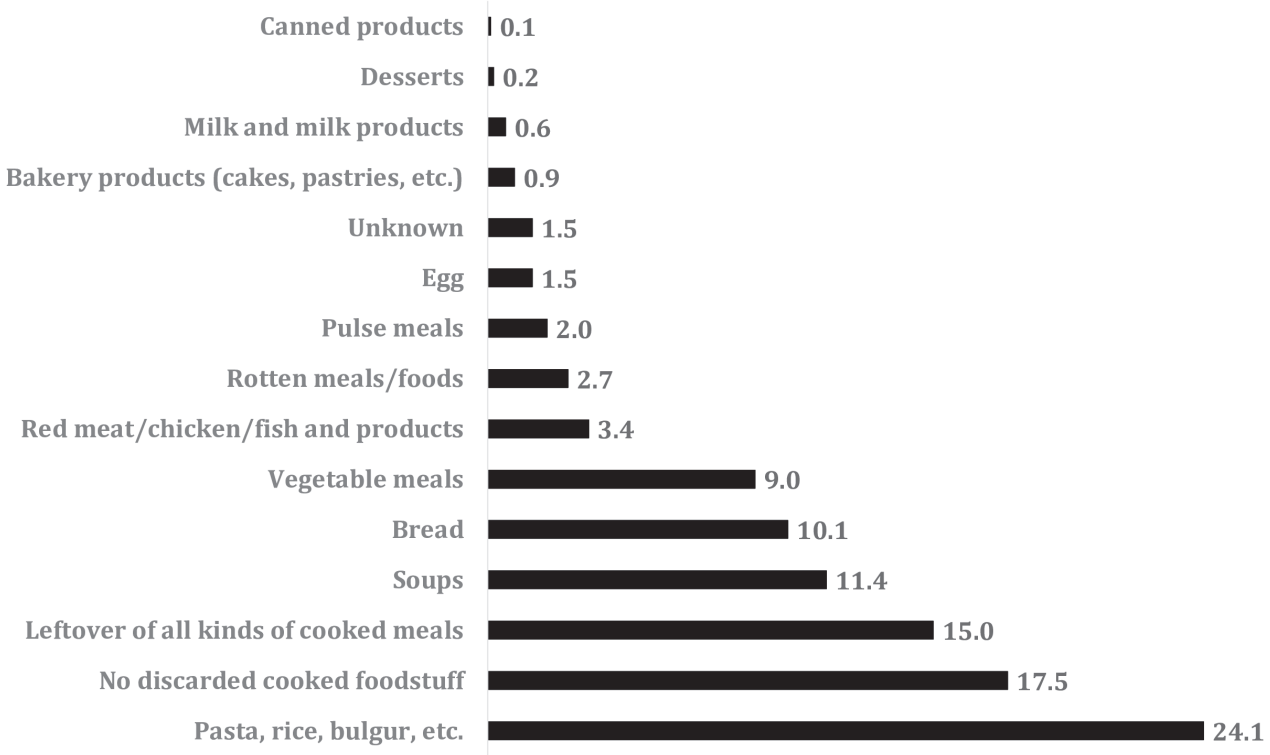


Figure 3. Cooked foods discarded most frequently (%)

ISSN-Internet 2197-411x OLCL 862804632

Table 4. Reasons for discarding foods

	n	%
Formation of mold, etc. on the food	**1115**	**18.1**
Storage of food for an excessive period of time in the refrigerator	**1006**	**16.3**
Expired products	**919**	**14.9**
Impaired taste of food	844	13.7
Storage of foods for an excessive period of time inside the store cupboard	485	7.9
Bad appearance of food	383	6.2
Big serving sizes of prepared meals	295	4.8
Dislike of any ingredient of a certain food or meal	271	4.4
Failure to plan shopping well	254	4.1
Erroneous preservation (storage) method at home	230	3.7
Big sizes (excessive amount) of packaged foods	160	2.6
Problems with cooking skills	138	2.2
Simultaneous serving of similar meals	57	0.9

***Multiple responses were provided.**

Table 5. Assessment of some factors affecting the generation of food wastes

Average Amount of Food Discarded in a Month		
	r	**p**
Socio-demographic factors (n=1343)*		
Age	**-0.079**	**0.004**
Level of education	0.023	0.401
Average monthly income	0.026	0.349
Average weekly household food expenditure (**n=1316**)*	**0.101**	**0.000**
Number of individuals living in the household	0.039	0.150
Number of women living in the household	**0.072**	**0.008**
Number of children aged 6-11 living in the household	0.002	0.933
Residential area	**-0.060**	**0.028**
Factors for shopping (n=1343)*		
Frequency of going for food shopping in the household	**0.122**	**0.000**
Purchase of any unnecessary products during good shopping	**0.177**	**0.000**
Frequency of purchasing foods and forgetting them in the cabinet (refrigerator/store cupboard, etc.) after using them for once, and noticing that they have not been used again	**0.212**	**0.000**
Checking the refrigerator/store cupboard	**-0.123**	**0.000**
Creation of a shopping list	**-0.077**	**0.005**
Factors for preparing, cooking and consuming meals (n=1343)*		
Frequency of cooking at home	-0.048	0.077
Frequency of ordering meals to home	**0.104**	**0.000**
Frequency of eating any previously-cooked meal at home	-0.026	0.350
Frequency of enjoying meals with friends/guests at home	0.026	0.350
Cooking skills	-0.035	0.195
Time of determination of the meal to be cooked	**-0.067**	**0.014**
Frequency of preparing meals with fresh foods	**-0.056**	**0.042**
Frequency of preparing meals with take-home foods (canned, frozen products, etc.)	**0.086**	**0.002**

Continue Table 5. Assessment of some factors affecting the generation of food wastes

Average Amount of Food Discarded in a Month		
	r	**p**
Frequency of trying new recipes in the kitchen	0.008	0.765
Frequency of considering the serving size of any meal as big while cooking or serving such meal	**0.085**	**0.002**

***Individuals, who don't know their waste amount and average weekly household food expenditure, are excluded.**

4. Discussion

The study results have shown that there is a negative relationship among the sociodemographic factors of age and residential area and the amount of food waste generated by the household. However, there is a positive relationship between the number of women living in a household and the average weekly food expenditure. Occupation was also shown to have a significant difference in the amount of food waste generated by a household ($p<0.05$). It has been observed that there is a positive yet insignificant relationship between the level of education, average monthly income, the number of individuals living in a household, the number of children aged 6-11 living in a household and the amount of food waste generated. It is known that the young people, women, adults with children aged under 14, self-employed individuals, those with a higher number of individuals living in a household, and people living in metropolitans generate more food wastes (Barr, 2007; Hamilton *et al.,* 2005; Koivupuro *et al.,* 2012; Lyndhurst *et al.,* 2007; Mattar *et al.,* 2018; Secondi *et al.,* 2015; Szabó-Bódi *et al.,* 2018; Visschers *et al.,* 2016).

On the other hand, Neff et al. (2015) found that living in urban or rural areas does not have a significant impact on the generation of food waste. The results obtained from the studies on the relationship between the average monthly income of the households and the amount of waste generated should be discussed. Although studies have determined there is a positive or negative relationship between the income and the amount of food waste (Cox *et al.,* 2010; Farr-Wharton *et al.,* 2014; Hamilton *et al.,* 2005; Lyndhurst *et al.,* 2007; Setti *et al.,* 2016; Stefan *et al.,* 2013), some studies have revealed that there is no relation between such factors (Bolaane & Ali, 2004; Koivupuro *et al.,* 2012; Quested *et al.,* 2013; Williams *et al.,* 2012; WRAP, 2009). Arguably, higher food waste generation in low-income households is due to a lack of skills, excessive purchasing, purchase of products of low-price and low-quality, and the will to fulfil the obligations of being a parent and to provide as much food as possible at home (Setti *et al.,* 2016; Porpino *et al.,* 2015). Monier et al. (2010) and Secondi et al. (2015) underline the relation between the level of education and the amount of food waste. They have shown that a lower level of education leads to the generation of less food waste. This result can be explained with the fact that individuals with a higher level of education tend to have a higher level of income and therefore spend more. Conversely, it should also be noted that some individuals with a low level of education might not be able to estimate the amount of food waste generated accurately. The relationship between an occupation and the generation of food waste can be explained with the fact that those with higher working hours have time restrictions due to excessive workload. Therefore, the amount of waste generated while preparing meals may go unnoticed, which may increase the generation of waste (Jorissen *et al.,* 2015).

Results further revealed that those shopping from supermarkets generate more (1-3 kg) food waste compared to those shopping from any other points ($p<0.05$). Also, special offers have a positive impact on the decision to purchase during shopping, which in turn impacts the amount of food waste generated; however, this finding was not statistically significant ($p>0.05$). It is considered that shopping frequently might increase the amount of food waste as it might trigger unplanned and spontaneous purchases. Furthermore; the households purchasing their foods generally from supermarkets tend to generate more food waste than the ones who prefer mini markets and the other points of shopping (Ponis *et al.,*2017). One assumption is that since supermarkets offer much more variety of products than mini markets and other smaller food retailers, more purchases are made and

ISSN-Internet 2197-411x OLCL 862804632

thus, the amount of food waste increases. It is known that creating a shopping list and checking the available stocks at home (refrigerator/store cupboard) can help reduce food waste at the household level (Bell *et al.,* 2011; Chandon & Wansink, 2006; Sharp *et al.,* 2010; Stefan *et al.,* 2013; WRAP, 2009). Since planned shopping ensures the purchase of necessary products while preventing the purchase of any unnecessary products, it leads to less food waste. The study conducted by Mattar et al. (2018) in Lebanon shows that falling under the influence of special offers increases the amount of food waste. The reason for this might be excessive purchases due to such special offers (Beretta *et al.,* 2013; Ganglbauer *et al.,* 2013; Koivupuro *et al.,* 2012; Lyndhurst *et al.,* 2007; Stefan *et al.,* 2013).

Food waste may increase with an increase in the frequency of enjoying meals with friends/guests at home that includes various meals of larger serving sizes, and an increase in the frequency of trying new recipes in the kitchen that may lead to non-consumable meals. Increased frequency of considering the serving size of any meal as big while cooking or serving such a meal suggests that meals are often over-sized, and also that more waste might be generated. A low frequency of cooking meals at home, poor cooking skills, and failure to use/consume leftover might lead to the unnecessary discarding of foods. Since the determination of the meal to be cooked beforehand results in preparation/cooking of meals in a more planned manner, it might contribute to the minimisation of waste (Lyndhurst *et al.,* 2007; Porpino *et al.,* 2015). This study demonstrates that a great majority of these factors are associated with the amount of food waste generated.

The raw and cooked foods discarded from households most frequently are vegetables (35.7%), and pasta, rice, bulgur (24.1%), respectively. The types of discarded foods vary by country. The main discarded foods are as follows by country: home-made foods and milk products in Finland (Silvennoinen *et al.,* 2014); bakery products in Norway (Hanssen *et al.,* 2016); fresh vegetables and salads in England (WRAP, 2009); home-made and previously-cooked meals in Hungary (Szabó-Bódi *et al.,* 2018); fruits, vegetables, bread and bakery products in Canada (van der Werf, 2018); cereals and bakery products in Algeria (Arous *et al.,* 2017); pasta, fast food, previously-cooked meals, vegetables, fruits and bread in Italy (Gaiani *et al.,* 2018; Lanfranchi *et al.,* 2016). The different food cultures may explain the reason for the differences in discarded food types.

From the reasons for discarding foods from the household (Table 4), most selected the formation of mould or spoilage on foods (18.1%), excessive storage period in the refrigerator (16.3%) and expired foods (14.9%). Similarly, the reasons of food waste suggested by other researchers are the storage of foods for an excessive period in the refrigerator/deep freeze, expired foods, deterioration of organoleptic properties of foods (formation of mould, etc.), a dislike of eating any previously-cooked meals, purchase of foods in excessive amounts, and inaccurate calculations of portion sizes while serving (Arous *et al.,* 2017; Gaiani *et al.,* 2018; Ghinea & Ghiuta, 2018; Lanfranchi *et al.,* 2016; van der Werf, 2018). The discarding of foods is generally caused by an insufficient level of attention, information and awareness from the individual.

The average amounts of food waste indicated to be discarded from households in a month was 0-1 kg by 32.9% of the participants, while 30.8% of them have indicated to generate a food waste amount of 1-3 kg. During a study conducted in Algeria with 323 participants, when the participants were asked about the amount of waste generated by them in a week, 21.0% of them indicated to generate less than 250 g, 13.0% of them have indicated to generate waste of 250-500 g, and 2.0% of them indicated to generate more than 2 kg of waste (Arous et al. 2017). Lanfranchi et al. (2016) found in a study of 500 participants that 1.4% generated 1-2 kg of waste, while 0.8% of them generated more than 2 kg of waste. The differences in waste amounts generated from households in the different studies may be attributed to the different features of the participants, such as educational status, economic conditions, social culture. On the other hand, it should be noted that all food waste, whether low or high amounts, will cause unfavourable environmental, social and economic impacts.

The relationship between the sense of feeling guilty for discarding foods and the amount of food waste generated by households has been considered significant in statistical terms ($p<0.05$). It has been observed that participants who responded "Yes" to the question of whether they feel guilty for discarding foods tend to generate less food waste compared to those who responded "Sometimes" and "No" to such question.

Other studies have also found that the sense of "feeling guilty" about waste production has the effect of minimising the amount of food waste by individuals (Lyndhurst *et al.,* 2007; Hamilton *et al.,* 2005; Mattar *et al.,* 2018; Qi & Roe, 2016; Stefan *et al.,* 2013). Conversely, it should be noted that the participants might have wanted to appear "good", and responded that they felt guilty for discarding foods, which might lead to misleading results.

Participants were requested to provide suggestions to minimise food waste, and some of the most common responses were as follows: "provision of more information to people about the environmental impacts of food waste" (19.1%); "creation of recipes for reuse of any leftover meals/foods" (15.7%); "raising the level of awareness of people on the monetary value of food waste" (13.1%); and "raising the level of awareness of people on the social impacts of food wastes" (13.1%). Personal concerns such as money-saving are known to be a stronger motivation than environmental and social concerns to minimise food waste (Graham-Rowe *et al.,* 2014; Neff *et al.,* 2015; Stancu *et al.,* 2016). van der Werf (2018) observed that the most common factor in minimising waste in most participants was the minimisation of money, followed by minimisation of environmental and social impacts. Under the scope of a study conducted by Arous et al. (2017), 45.0% of the participants indicated that if they were provided with more information on the unfavourable effects of food waste on the economy, they would generate less food waste. At the same time, 35.0% of them indicated that they consider that imposing an additional tax on waste could be effective in minimising food waste. Gaiani et al. (2018) have underlined that if people were obliged to pay money for waste generated by them and if they were provided with more information on the financial, environmental, and social impacts of waste, such wastes could be minimised. Lanfranchi et al. (2016) suggested that the principal strategies to reduce waste include smaller food servings, placing additional costs on personal waste, and also that more information should be provided regarding the impacts of food waste on the environment and economy.

It has been found out that more than half of the participants have read, seen or heard something in the last six months about food waste or ways to minimise food waste. However, only 11.6% of them said to be familiar with any of the practices, initiative, or campaigns addressing food waste across the country or by local households. Findings revealed that 93.2% of the participants would like to receive more information about ways to minimise food waste, and 76.0% would spend extra time and effort to eliminate food waste. Besides, 64.8% of respondents would like to be involved in any future practice, study, or campaign aimed at minimising food waste in the household. Interestingly, a great majority of participants would like more information on ways to prevent food waste, and more than half of them would like to be involved in practices, studies, or campaigns for the minimisation of waste. It is questionable to what extent the provision of information alone could be effective towards the minimisation of food waste if it all. Besides the provision of information, the assumption of personal responsibility in minimisation of waste will have the highest effect.

5. Conclusions

Discarding foods unnecessarily leads to unfavourable conditions in financial, environmental and social terms. Households represent the major group generating food waste throughout the food supply chain. Therefore, the prevention of waste in households is of great importance. Due to the close relationship between the prevention of food waste in households and individual behaviours of the residents, analysis of individual characteristics (sociodemographic features, behaviour and attitude features) is highly critical to develop appropriate strategies.

The results obtained in this study have revealed that sociodemographic features, food shopping practices, food preparation, cooking and consumption habits, and attitudes for food waste might have a direct impact on the decrease or increase of food waste in Turkey. These findings, thought to be related to the generation of waste, should be taken into account by the government when developing waste prevention strategies. All initiatives should be ensured, as necessary, through awareness-raising campaigns on TV and other media using influential and simplified messages towards individuals' behaviours for the generation of waste. The amount of training for household routines such as shopping and menu planning, storage, and preparation of foods should be increased. Situations leading to the generation of waste can be eliminated by raising the level of awareness and in-

ISSN-Internet 2197-411x OLCL 862804632

formation available to individuals about the purchase, storage, preparation, cooking and serving of goods. Moreover, waste prevention strategies should aim at motivating individuals to minimise their food waste, and increasing the level of awareness on the unfavourable impacts of food waste. Also, individuals should be more conscious about shopping habits, preparing and cooking food, preserving food and being aware of the adverse effects of waste, and take responsibility for the necessary precautions.

Study limitations

One significant limitation of the present study is the non-probabilistic sampling design used for data collection as respondents were recruited voluntarily. Therefore, it is likely that a self-selection bias exists and specific characteristics are emphasised but do not ensure either a statistical significance or the extension of the results to the entire Turkish population. At the same time, convenience samples like the one used in this study are often utilised to explore topics that are not yet covered by comprehensive literature. It is worth underlining that, compared to other surveys conducted on food waste in Turkey, the identified sample is relatively larger and still provides relevant insights as it is quite heterogeneous in terms of respondents' profiles. Another limitation is that there were more females and more consumers from metropolitan areas in the population under study. However, having a higher number of women in the sample is rather ordinary in food-related studies, since women generally hold more of the responsibility in cooking and shopping than males, and are more willing to answer questionnaires related to food issues.

Conflict of Interest

The authors declare that there is no conflict of interest. Also, there was no funder in the decision to collect, analyse or interpret data, write the article and publish the results.

References

Abdelradi, F. (2018). Food waste behaviour at the household level: A conceptual framework. Waste Management, 71, 485–493. doi: 10.1016/j.wasman.2017.10.001

Arous, S.A., Capone, R., Debs, P., Haddadi, Y., El Bilali, H., Bottalico, F., & Hamidouche, M. (2017). Exploring household food waste issue in Algeria. International Journal, 2(1), 55-67. doi: 10.7251/AGRENG1701055A

Aschemann-Witzel, J., De Hooge, I., Amani, P., Bech-Larsen, T., & Oostindjer, M. (2015). Consumer-related food waste: causes and potential for action. Sustainability, 7(6), 6457–6477. doi: 10.3390/su7066457

Aschemann-Witzel, J., De Hooge, I., Rohm, H., Normann, A., Bonzanini Bossle, M., Grønhøj, A., et al. (2017a). Key characteristics and success factors of supply chain initiatives tackling consumer-related food waste e a multiple case study. Journal of Cleaner Production, 155(2016), 33-45. doi: 10.1016/j.jclepro.2016.11.173

Aschemann-Witzel, J., Jensen, H.J., Jensen, M.H., & Kulikovskaja, V. (2017b). Consumer behaviour towards price-reduced suboptimal foods in the supermarket and the relation to food waste in households. Appetite, 116, 246- 258. doi: 10.1016/j.appet.2017.05.013

Barr, S. (2007). Factors influencing environmental attitudes and behaviours: A U.K. case study of household waste management. Environment and Behaviour, 39, 435–473. doi: 10.1177/0013916505283421

Bell, D.R., Corsten, D., & Knox, G. (2011). From point of purchase to path to purchase: How preshopping factors drive unplanned buying. Journal of Marketing, 75(1), 31-45. doi: 10.1509/jm.75.1.31

Beretta, C., Stoessel, F., Baier, U., & Hellweg, S. (2013). Quantifying food losses and the potential for reduction in Switzerland. Waste Management, 33, 764–773. doi: 10.1016/j.wasman.2012.11.007

Bolaane, B., & Ali, M. (2004). Sampling household waste at source: lessons learnt in Gaborone. Waste Management & Research, 22 (3), 142-148. doi: 10.1177/0734242X04044970

Chandon, P., & Wansink, B. (2006). How biased household inventory estimates distort shopping and storage decisions. Journal of Marketing, 70(4), 118-135. doi: 10.1509/jmkg.70.4.118

Cox, J., Giorgi, S., Sharp, V., Strange, K., Wilson, D.C., & Blakey, N. (2010). Household waste prevention-a review of evidence. Waste Management & Research, 28 (3), 193-219. doi: 10.1177/0734242X10361506

Evans, D. (2012). Beyond the throwaway society: ordinary domestic practice and a sociological approach to household food waste. Sociology, 46, 41–56. doi: 10.1177/0038038511416150

Farr- Wharton, G., Foth, M., & Choi, J.H.J. (2014). Identifying factors that promote consumer behaviours causing expired domestic food waste. Journal of Consumer Behaviour, 13(6), 393-402. doi: 10.1002/cb.1488

Gaiani, S., Caldeira, S., Adorno, V., Segrè, A., & Vittuari, M. (2018). Food wasters: Profiling consumers' attitude to waste food in Italy. Waste Management, 72, 17–24. doi: 10.1016/j.wasman.2017.11.012

Ganglbauer, E., Fitzpatrick, G., & Comber, R. (2013). Negotiating food waste: using a practice lens to inform design. ACM Transactions on Computer-Human Interaction, 20(2), 1-25. doi: 10.1145/2463579.2463582

Ghinea, C., & Ghiuta, O.A. (2018). Household food waste generation: young consumers behaviour, habits and attitudes. International Journal of Environmental Science and Technology, 16, 2185–2200. doi:10.1007/s13762-018-1853-1

Graham-Rowe, E., Jessop, D.C., & Sparks, P. (2014). Identifying motivations and barriers to minimising household food waste. Resources, Conservation and Recycling, 84, 15-23. doi: 10.1016/j.resconrec.2013.12.005

Griffin, M., Sobal, J., & Lyson, T.A. (2009). An analysis of a community food waste stream. Agriculture and Human Values, 26(1-2), 67-81. doi: 10.1007/s10460-008-9178-1

Hamilton, C., Denniss, R., & Baker, D. (2005, March). Wasteful consumption in Australia. The Australia Institute. Retrieved from www.tai.org.au/documents/dp_fulltext/DP77.pdf

Hanssen, O.J., Syversen, F., & Stø, E. (2016). Edible food waste from Norwegian households – detailed food waste composition analysis among households in two different regions in Norway. Resources, Conservation and Recycling, 109, 146-154. doi: 10.1016/j.resconrec.2016.03.010

Janssen, M.A., Nijenhuis-De Vrıes, M.A., Boer, E.P.J., & Kremer, S. (2017). Fresh, frozen, or ambient food equivalents and their impact on food waste generation in Dutch households. Waste Management, 67, 298–307. doi: 10.1016/j.wasman.2017.05.010

Jorissen, J., Priefer, C., & Brautigam, K.R. (2015). Food waste generation at household level: results of a survey among employees of two European research centers in Italy and Germany. Sustainability, 7(3), 2695-2715. doi: 10.3390/su7032695

Koivupuro, H.K., Hartikainen, H., Silvennoinen, K., Katajajuuri, J.M, Heikıntalo, N., Reinikainen, A., & Jalkanen, L. (2012). Influence of socio-demographical, behavioural and attitudinal factors on the amount of avoidable food waste generated in Finnish households. International Journal of Consumer Studies, 3(2), 183-191. doi: 10.1111/j.1470-6431.2011.01080.x

Kummu, M., De Moel, H., Porkka, M., Siebert, S., Varis, O., & Ward, P.J. (2012). Lost food, wasted resources: global food supply chain losses and their impacts on freshwater, cropland, and fertiliser use. Science of the Total Environment, 438(0), 477-489. doi: 10.1016/j.scitotenv.2012.08.092

Lanfranchi, M., Calabro, G., De Pascale, A., Fazio, A., & Giannetto, C. (2016). Household food waste and eating behavior: empirical survey. British Food Journal, 118, 3059-3072. doi: 10.1108/BFJ-01-2016-0001

Lyndhurst, B., Cox, J., & Downing, P. (2007). Food Behaviour Consumer Research: Quantitative Phase. Waste & Resources Action Programme (WRAP). Retrieved from https://www.wrap.org.uk/sites/files/wrap/Food%20behaviour%20consumer%20research%20quantitative%20jun%202007.pdf

Mallinson, L.J., Russell, J.M., & Barker, M.E. (2016). Attitudes and behaviour towards convenience food and food waste in the United Kingdom. Appetite, 103, 17–28. doi:10.1016/j.appet.2016.03.017

ISSN-Internet 2197-411x OLCL 862804632

Mattar, L., Abiad, M.G., Chalak, A., Diab, M., Hassan, H. (2018). Attitudes and behaviors shaping household food waste generation: Lessons from Lebanon. Journal of Cleaner Production, 198, 1219-1223. doi: 10.1016/j.jclepro.2018.07.085

Mondejar-Jimenez, J.A., Ferrari, G., Secondi, L., & Principato, L. (2016). From the table to waste: an exploratory study on behaviour towards food waste of Spanish and Italian youths. Journal of Cleaner Production, 138, 8-18. doi: 10.1016/j.jclepro.2016.06.018

Monier, V., Shailendra, M., Escalon, V., O'Connor, C., Gibon, T., Anderson, G., Hortense, M., & Reisinger, H. (2011). Preparatory Study on Food Waste across EU 27. European Commission (DG ENV) Directorate C- Industry. Retrieved from https://ec.europa.eu/environment/eussd/pdf/bio_foodwaste_report.pdf

Neff, R.A., Spiker, M.L., & Truant, P.L. (2015). Wasted Food: U.S. Consumers' Reported Awareness, Attitudes, and Behaviors. PLOS ONE, 10(6), 0127881. doi: 10.1371/journal.pone.0127881

Parfitt, J., Barthel, M., & Macnaughton, S. (2010). Food waste within food supply chains:quantification and potential for change to 2050. Philosophical Transactions of the Royal Society B: Biological Sciences, 365, 3065-3081. doi: 10.1098/rstb.2010.0126

Parizeau, K., Von Massow, M., & Martin, R. (2015). Household-level dynamics of food waste production and related beliefs, attitudes, and behaviours in Guelph, Ontario. Waste Management, 35, 207-217. doi: 10.1016/j.wasman.2014.09.019

van der Werf, P. (2018). Developing and Testing a Novel Intervention to Reduce Household Food Waste (PhD Thesis). Western University, Canada.

Ponis, S.T., Papanikolaou, P.A., Katimertzoglou, P., Ntalla, A.C., & Xenos, K.I. (2017). Household food waste in Greece: a questionnaire survey. Journal of Cleaner Production, 149, 1268-1277. doi: 10.1016/j.jclepro.2017.02.165

Porpino, G., Parente, J., & Wansink, B. (2015). Food waste paradox: antecedents of food disposal in low income households. International Journal of Consumer Studies, 39, 619-629. doi: 10.1111/ijcs.12207

Principato, L., Secondi, L., & Pratesi, C.A. (2015). Reducing food waste: an investigation on the behavior of Italian youths. British Food Journal, 117(2), 731-748. doi: 10.1108/BFJ-10-2013-0314

Qİ, D., & Roe, B.E. (2016). Household food waste: multivariate regression and principal components analyses of awareness and attitudes among US consumers. PLOS ONE, 11, -0159250. doi: 10.1371/journal.pone.0159250

Quested, T., Marsh, E., Stunell, D., & Parry, A. (2013). Spaghetti soup: the complex World of food waste behaviours. Resource, Conservation and Recycling, 79, 43-51. doi: 10.1016/j.resconrec.2013.04.011

Secondi, L., Principato, L., & Laureti, T. (2015). Household food waste behaviour in EU-27 countries: a multilevel analysis. Food Policy, 56, 25-40. doi: 10.1016/j.foodpol.2015.07.007

Setti, M., Falasconi, L., Sergè, A., Cusano, I., & Vittuari, M. (2016). Italian consumeŕ income and food waste behavior. British Food Journal, 118, 1731–1746. doi: 10.1108/BFJ-11-2015-0427

Sharp, V., Giorgi, S., & Wilson, D.C. (2010). Delivery and impact of household waste prevention intervention campaign (at the local level). Waste Management and Research, 28, 256–268. doi:10.1177/0734242X10361507

Silvennoinen, K., Katajajuuri, J.M, Hartikainen, H., Heikkilä, L., & Reinikainen, A. (2014). Food waste volume and composition in Finnish household. British Food Journal, 116(6), 1058-1068. doi: 10.1108/BFJ-12-2012-0311

Stancu, V., Haugaard, P., & Lahteenmaki, L. (2016). Determinants of consumer food waste behaviour: two routes to food waste. Appetite, 96, 7-17. doi: 10.1016/j.appet.2015.08.025

Stefan, V., Van Herpen, E., Tudoran, A.A., & L€Ahteenm€Aki, L. (2013). Avoiding food waste by Romanian consumers: the importance of planning and shopping routines. Food Quality and Preference, 28, 375-381. doi: 10.1016/j.foodqual.2012.11.001

Szabó-Bóiı, B., Kasza, G., & Szakos, D. (2018). Assessment of household food waste in Hungary. British Food Journal, 120(3), 625-638. doi: 10.1108/BFJ-04-2017-0255

Tucker, C.A., & Farrelly, T. (2015). Household food waste: The implications of consumer choice in food from purchase to disposal. Local Environment, 21(6), 682-706. doi: 10.1080/13549839.2015.1015972

Visschers, V., Wickli, N., & Siegrist, M. (2016). Sorting out food waste behaviour: A survey on the motivators and barriers of self-reported amounts of food waste in households. Journal of Environmental Psychology, 45, 66-78. doi: 10.1016/j.jenvp.2015.11.007

Williams, H., Wikstrom, F., Otterbring, T., Lofgren, M., & Gustafsson, A. (2012). Reasons for household food waste with special attention to packaging. Journal of Cleaner Production, 24, 141–148. doi: 10.1016/j.jclepro.2011.11.044

WRAP. (2009). Household food and drink waste in the UK. Waste & Resources Action Programme (WRAP). Retrieved from https://www.wrap.org.uk/sites/files/wrap/Household_food_and_drink_waste_in_the_UK_-_report.pdf

ISSN-Internet 2197-411x OLCL 862804632

Future of Food: Journal on Food, Agriculture and Society
9 (2) May 2021

Nutrient and oil profile of Escamol, an edible larva of ants *(Liometopum apiculatum Mayr)*

Fernanda Escamilla[1], José Ariza[1*]

[1]Área Académica de Nutrición, Instituto de Ciencias de la Salud, Universidad Autónoma del Estado de Hidalgo, San Agustín Tlaxiaca, Hidalgo, México

* Corresponding author: jose190375@hotmail.com

Data of the article

First received : 18 May 2020 | Last revision received : 17 December 2020
Accepted : 05 January 2021| Published online :25 May 2021
DOI : 10.17170/kobra-202102163259

Keywords

butter-fried; fatty acids; *Liometopum apiculatum* Mayr.

The object of this study was to evaluate nutrient content and oil profile in Escamol, which are edible ants native to Mexico. These are dehydrated and butter-fried, and they are commercially available in Mexico. The nutrient content was analysed by using proximal analysis, while the oil profile and its quality were analysed using a refractive index and physicochemical analysis, respectively. The results of the proximal chemical analysis of fresh Escamol showed moisture (56.00±0.00 %), protein (15.30±0.50 %), lipids (20.05±0.37 %), ash (1.91±0.12 %), and carbohydrates (6.73±0.00 %) percentages fall within the parameter reported for the order Hymenoptera ($p < 0.05$) compared with butter-fried Escamol ($p < 0.05$). The moisture (1.53 %) in Escamol oil accelerates the degradation of the triacyl-glycerides, producing free fatty acids (17.48 % oleic acid). At the same time, frying increases lipids with double linkages (133. 79 cg I2 g-1) and causes oxidation products (3.60 meq O2 kg-1 of oil). The Escamol oil extracted from the dehydrated and butter-fried sample showed a refractive index similar to beeswax (1.442) and pure edible coconut oil (1.447), respectively. Therefore, they would mainly present fatty acids as the lauric acid [C12:0 (41.00-56.00 %)], monounsaturated: palmitoleic acid [C16:1 (12.00 %)] and oleic acid [C18:1 (3.50-11.00 %)] and polyunsaturated: linoleic acid [C18:2 (1.00-2.5 %)]. The frying has a minimal effect on the chemical composition of the oil and the fatty acids in Escamol.

1. Introduction

Insects are part of the human diet in many parts of the world (Melgar-Lalanne *et al.,* 2019). These are processed in a number of ways (steaming, roasting, smoking, stewing, curing, and frying, to mention a few) (Ramos-Elorduy *et al.,* 2007) in order to improve their sensory and nutritional qualities as well as their shelf-life (Melgar-Lalanne *et al.,* 2019). The orders of species with greater consumption are Orthoptera, Hemiptera, Coleoptera, and Hymenoptera. The Hymenoptera order includes ants from the Formicidae family, whose diversity is defined by latitude and altitude features (Kusnezov, 1975). The greatest distribution of ants takes place in tropical and subtropical forests of low altitude, as well as in the deserts throughout the world (Brown *et al.,* 1973).

In Mexico, there are five edible ants: Atta cephalotes, Atta mexicana, Myrmecosistus melliger, Myrmecosistus mexicanus, and *Liometopum apiculatum* Mayr (Ramos-Elorduy, 2009). The ant species *Liometopum apiculatum* Mayr is generally obtained during the pupae or larvae stage, known as Escamol or in plural, Escamoles, which are the immature stages of the breeding castes of drones or princesses (Lara-Juárez *et al.,*

2015). The pupae or larvae are eaten in several parts of Central Mexico (Ramos-Elorduy *et al.,* 2007), due to their exquisiteness and nutritional value (Ladrón *et al.,* 1995). They represent a part of the diets and economic incomes of rural communities, and the regional price range between $ 960 pesos ($ 49 USD) and $ 4800 pesos ($ 243 USD) per kilo (Ramos-Elorduy, *et al.,* 2006). Therefore, this study aims to evaluate nutrient content and oil profile of Escamol to ascertain its quality, using proximal chemical analysis and instrumental techniques, respectively.

2. Materials and methods

2.1 Samples

Escamoles (500 g each) were purchased fresh and fried (seasoned with butter), such as they are consumed by the people of the cities of the State of Hidalgo, Mexico. The samples of fresh Escamoles were frozen (-30 °C) and stored until ready for use. Subsequently, these Escamoles samples were thawed at 25 °C. They were dehydrated in a drying oven (Terlab trademark, México) at 70 °C for 4 h. The three Escamoles samples (fresh, dehydrated and butter-fried) were homogenised separately using a blender (Oster Besto2-E01, United States) until a particle size of 250 µm was reached. The Escamoles homogenised samples (fresh, dehydrated and butter-fried) proximal chemical analyses were defined.

2.2 Proximal analysis

The homogenised samples (fresh, dehydrated and butter-fried) Escamoles were analysed to define their moisture (method 926.08), proteins (method 955.04), lipids (method 945.16), and ashes (method 900.02), content according to the methods reported by the Official Association of Analytical Chemistry (AOAC, 2019). The amount of carbohydrates was obtained by the difference. The oil moisture was also determined, and each of the treatments was performed in triplicate.

2.3 Oil extraction

2.3.1 Extraction by Soxhlet

Since the dehydrated and butter-fried Escamoles samples are the two cooking methods most commonly consumed in Hidalgo State, each one of these was placed in an extraction thimble-holder (1 g) to compare its oil. For the oil extraction, the thimble-holder with each one of the Escamoles samples was placed inside the Soxhlet extractor with petroleum ether at 40 °C during 4 h (method 945.16) (AOAC, 2019). The petroleum ether was poured into a round bottom flask attached to an extractor and flask as well as a condenser. The round bottom flask with petroleum ether was heated (40 °C) and this solvent was volatilised. The petroleum ether condensate was poured into the extractor with the thimble-holder. During the extraction, the extractor was gradually filled with condensed solvent. When the solvent reached an overflow level, it produced a siphon with analytes from the entire contents of the thimble-holder and discharged them back into the round bottom flask, and the cycle repeats. The process was run for 4 h (AOAC, 2019). The solvent and oil mixture were stripped using a rotary vacuum evaporator under vacuum at a temperature of 50 °C at a half rotational rate (Büchi, Heating Bath B-490, Mexico) coupled to a vacuum pump (Büchi, Vacuum Rump V-700, Mexico).

2.3.2 Physicochemical analysis of the oil

The quantification of the quality of Escamoles oils was carried out under the Mexican standards such as moisture NOM-116-SSA1-1994 (NMX 1994), acidity NMX-F-101-SCFI-2012 (NMX 2012), iodine NMX-F-152-SCFI-2011 (NMX 2011a), and peroxide NMX-F-154-SCFI-2010 (NMX 2010). Each of the analyses was performed in triplicate.

2.4 Fatty acid identification

In order to identify the fatty acids in dehydrated and butter-fried Escamoles, an Abbe refractometer (ATAGO, Master-RI, USA) was used. The results were compared consulting the table of refractive index of the oils included in the equipment, and the percentages were searched in the corresponding bibliography. The refractive index is the ratio of the sine of the angle of incidence and the sine of the angle of refraction, angles that are formed when passing a light beam from the air into another medium, in which the light propagates at different rates. Each analysis was performed in triplicate.

ISSN-Internet 2197-411x OLCL 862804632

2.5 Statistical analysis

The results of the proximal analyses, chemical indexes and refractive indexes are expressed as mean and standard deviation applying a Student T-test for independent samples with a 95% confidence range. The results of dehydrated and butter-fried Escamoles were compared using the statistical software IBM SPSS Statistics version 22 (IBM Corp. Released 2013. Armonk, NY: IBM Corp).

3. Results

3.1 Proximal analysis

Table 1 shows the results of the proximal chemical composition of the Escamoles samples.

The Escamoles results on a wet basis were lower when comparing this percentage with those reported by Ramos et al. (2012) with 60.57-71.90% analysed in the Municipalities of San Juan Teotihuacán and Otumba in Mexico. Hence, the moisture content in the insect depends on climatic and geographic conditions (Juárez *et al.,* 2010). The difference ($p < 0.05$) in the results on a wet basis in the percentage of protein, lipids, ash and carbohydrates is due to the stage of development of the insect (Ramos *et al.,* 2012).

The results of dehydrated Escamol are shown in Table 1, where the changes in its composition are due to the insect's physiology and diet (Ramos *et al.,* 2012). Comparably, butter-fried Escamol samples where the value increased for some parameters reflect the properties of butter, which are 16.17 %, 0.85 %, 81.11 % and 85.11 mg 100 g-1 of moisture, protein, lipids, and ashes respectively (USDA 2018).

3.2 Oil extraction and physicochemical analysis

Table 2 shows the results of the physicochemical analyses of the oils extracted from Escamoles.

The results of the moisture percentage in the dehydrated Escamol oil was high, due to the insect anatomy (Ghosh et al. 2017).

Table 1: Results in percentage of the proximal chemical analysis carried out in the Escamoles

Analysis (%)		**Fresh *Escamoles***
Moisture		56.00 ± 0.00
Crude protein		15.30 ± 0.50
Lipids		20.05 ± 0.37
Ash		1.91 ± 0.12
Carbohydrates		6.73 ± 0.00
Dehydrated (D) and Butter-fried (BF) *Escamoles* in dry basis		
Analysis (%)	Cooking methods	Escamol
Moisture	D	1.89 ± 0.38^{b}
	BF	2.84 ± 0.00^{a}
Protein	D	34.78 ± 1.15^{a}
	BF	32.86 ± 0.61^{a}
Lipids	D	45.57 ± 0.85^{b}
	BF	56.26 ± 1.79^{a}
Ash	D	4.35 ± 0.28^{a}
	BF	4.38 ± 0.04^{a}
Carbohydrates	D	13.41 ± 0.00^{a}
	BF	3.66± 0.00^{b}

Note: Average ± SD. Different superscript lowercase letters in the same column indicate significant difference ($p < 0.05$) between D: Dehydrated *Escamoles* and BF: Butter-Fried *Escamoles.*

The results of acidity index percentage in the dehydrated oil sample was high due to the moisture percentage in the Escamoles (Rivera *et al.,* 2014). In the determination of the iodine index in the oil obtained from the butter-fried Escamol this value was increased, compared with the oil obtained from the dehydrated Escamol. In the other hand, the peroxide index value of the oil obtained from dehydrated Escamol is within what is represented as maximum value for vegetable oils under the Mexican Standard NMX-F-808-SCFI-2018 with 2.0 meq O2 kg-1 (NMX, 2018). Therefore, the frying affects unsaturated fatty acids, producing free fatty acids and hydroperoxides.

3.3 Fatty acid identification

The identification of the fatty acids in Escamoles oil samples is presented in Table 3.

The Escamol oil extracted from the dehydrated sample presented a refractive index similar to that reported for beeswax. Whereas the Escamol oil extracted from the butter-fried sample had a refractive index similar to that represented for pure edible coconut oil, Table 4 shows its content of fatty acids (NMX, 2011c).

The oil in both Escamol samples had a higher content of saturated fatty acids, so it is suggested that it should be consumed in moderation.

4. Discussion

4.1 Proximal analysis

Table 2: Physical and chemical analyses of the oils extracted from Escamol

Index	Cooking methods	*Escamol*
Oil moisture (%)	D	1.53 ± 0.25^{a}
	BF	0.04 ± 0.05^{b}
Acidity index (% oleic acid)	D	17.48 ± 0.00^{a}
	BF	3.38 ± 0.00^{b}
Iodine index (cg I_2 g^{-1})	D	112.00 ± 8.59^{b}
	BF	133.79 ± 0.72^{a}
Peroxide index (meq O_2 kg^{-1})	D	0.80 ± 0.00^{b}
	BF	3.60 ± 1.69^{a}

Note: Average ± SD. Different lowercase superscript letters in the same column indicate significant difference ($p < 0.05$) between D: Dehydrated Escamoles and BF: Butter-Fried Escamoles.

Table 3: Results of the determination of refractive index in the oils Escamoles

Escamoles	Refractive index
Dehydrated	1.442 ± 0.00^{b}
Butter-Fried	1.447 ± 0.00^{a}

Note: Average ± SD. Different lower case superscript letters in the same column indicate significant difference ($p < 0.05$) between Dehydrated Insect Oil and Butter-fried Insect Oil.

ISSN-Internet 2197-411x OLCL 862804632

Due to its moisture content, Escamol favours the growth of microorganisms and biological reactions, resulting in the acceleration of the enzymatic activity, hydrolytic reactions, non-enzymatic darkening and lipid oxidation, so it is necessary to establish a preservation method such as dehydration or frying (Badui, 2013). Escamol in the pupa stage contains more lipids than during other stages, and this is similar to other insects in the pupa stage (Rumpold & Schlüter, 2013). The ash and carbohydrate percentage are affected by the insect diet (Ramos *et al.,* 2012) as shown in Table 1.

Table 1 shows that the percentage of protein in Escamol samples are within the parameter indicated for the order Hymenoptera (bees, wasps, and ants) of 10.00-81.00% and a percentage higher compared to beans 23.00% and lentils 27.00%. Also, it presents a lower percentage compared with chicken 43.00%, soy 44.00%, egg 46.00% and beef 54.00% (Conconi, 1993). Therefore, the protein found in Escamol, can be an alternative to meet protein requirements. On the other hand, the percentage of proteins in the butter-fried Escamol sample was lower compared to the dehydrated samples. However, this difference was not statistically significant. Besides, during frying, the absorbed fat increases until the food is saturated and present minimal losses of proteins, carbohydrates, and minerals (Bognár, 1998). These losses are due to long frying times and the use of temperatures above boiling temperatures that cause a decrease in the protein content (Zhang *et al.,* 2014) or the loss of nitrogen in the form of volatile nitrogen compounds (Yu *et al.,* 1993).

As for the percentage of Escamol lipids, its concentration was lower than those reported for the Hymenoptera order with 55.10 % (Rumpold & Schlüter, 2013). In another study carried out in Hidalgo, Estado de México and Puebla, Mexico, a percentage of 29.45-47.98 g 100 g-1 on a dry basis was reported (Ramos *et al.,* 2012). Hence, its concentration depends on factors such as species, reproductive stages, age (life stage), the season of year, habitat and diet (Raksakantong *et al.,* 2010). On the other hand, Table 1 shows that the lipids percentage increased due to the thermal process. During this process, a heat transfer occurs (Dana & Saguy, 2006), which causes dehydration (bark) and a wet core that when it cools, water vapour condenses inside the food, affecting the decrease in inner pressure, which exerts a vacuum effect, thus absorbing the lipids (Cortés *et al.,* 2014).

Table 4. Fatty acid content in pure edible coconut oil

Fatty acids	Percentage
Saturated fatty acids	
Caproic (C6:0)	0.00-1.2
Caprylic (C8:0)	5.50-9.50
Capric (C10:0)	4.50-9.50
Lauric (C12:0)	41.00-56.00
Myristic (C14:0)	13.00-19.00
Palmitic (C16:0)	7.50-12.00
Stearic (C18:0)	1.00-4.00
Monounsaturated fatty acids	
Oleic (C18:1)	3.50-11.00
Polyunsaturated fatty acids	
Linoleic (C18:2)	1.00-2.5

Content in percentage according to the Mexican standard (NMX, 2011c).

The ash values of the Escamol were similar, and are within the percentage indicated for the Hymenoptera order with 0.71-9.31 % (Rumpold & Schlüter, 2013) and the following minerals have been indicated: calcium (174.8 µg g-1), magnesium (455.3 µg g-1), sodium (823.6 µg g-1), potassium (3182.7 µg g-1), zinc (52.7 µg g-1), copper 9.3 (µg g-1) and iron (0.8 µg g-1) (Ramos *et al.,* 2012). Therefore, the Escamoles could be a source of mineral for diet. The results of the carbohydrate percentage in dehydrated Escamoles were high than the results reported in Hymenoptera order 7.15 % (Sun *et al.,* 2007). It is observed that in the butter-fried Escamol, this compound decreased, due to the Maillard reaction during frying (Torres-Cifuentes *et al.,* 2015).

4.2 Oil extraction and physicochemical analysis

The moisture percentage is a factor that accelerates the degradation of the unsaturated fatty acids, so it is necessary to reduce it, using a pre-treatment or during the oil refinement (degumming method) (Ariza *et al.,* 2004). According to the Mexican Standard for an edible vegetable oil NMX-F-808-SCFI-2018, it should have a maximum moisture concentration of 0.05 % (NMX 2018) (Table 2), and the butter-fried Escamol oil sample had a lower percentage due to this process (Dana & Saguy, 2006).

The results of the acidity index in the Escamol showed there are degraded chains of carbon atoms from long to short carbon structures (Rangaswamy & Nasirullah, 2016). Compared with butter-fried Escamol, this value is due to the interaction of lipids with degradation products with degradation products of the Maillard reaction, which cause the formation of various volatile chemical compounds (Yu *et al.,* 1993; Badui, 2013; Zhang *et al.,* 2014). It has been reported that an excess of free fatty acids is related to resistance to insulin, fatty liver disease, atherosclerosis and myocardial dysfunction (Vilarrasa, 2014).

The iodine index determined in the Escamoles oils extracted from butter-fried was high, probably due to the presence of vitamin A (684 µg 100 g-1) and vitamin E (2.32 mg 100 g-1) in the butter (USDA, 2018). The peroxide index in oil extracted from dehydrated Escamol indicated that this oil presented minimal changes in its composition of unsaturated fatty acids compared with oil obtained from the butter-fried Escamol. So, this oil is not suitable for consumption due to the formation of peroxides, which causes the presence of rancidity and free radicals that can increase the risk of developing degenerative diseases (Okparanta & Solomon, 2018).

4.3 Fatty acid identification

The Escamol oil extracted from the dehydrated sample presented a refractive index similar to that reported for beeswax, in that it could contain a high concentration of saturated fatty acids (85%), compared to monounsaturated fatty acids: palmitoleic acid [C16:1 (12.00 %)] and oleic acid [C18:1 (5.00 %)] (Jackson & Eller, 2006; Trillo, 2017). On the other hand, the Escamol oil extracted from the butter-fried sample is similar to that reported for pure edible coconut oil (NMX, 2011c). As observed in Table 4, it could contain mainly saturated fatty acids that are necessary for metamorphosis (Ying *et al.,* 2009).

Escamol oil contains saturated fatty acids, most of which are C12:00 and C14:0. The fatty acid C12:0 has antiviral and antibacterial health benefits for the human body (Abbas *et al.,* 2017). C14:0 can slightly decrease the ratio between total cholesterol and high-density lipoprotein cholesterol (Orsavova *et al.,* 2015). Among the unsaturated fatty acids that we can find in Escamol oil are C18:1 and C18:2. The former, C18:1 reduces the plasma concentrations of total cholesterol, and at low concentrations, C18:2 does not have an inflammatory effect (Nagy & Tiuca, 2017).

5. Conclusion

The butter-frying process in the Escamoles increased the percentage of lipids and decreased the percentage of proteins and carbohydrates, which caused changes in the oil, increasing the concentration of hydroperoxides. The dehydrated Escamoles presented high concentrations of saturated fatty acids, so it is suggested to use another type of lipid for frying.

Conflict of interest

The authors declare no conflict of interest.

Acknowledgments

ISSN-Internet 2197-411x OLCL 862804632

To the student of Master in Biomedical and Health Sciences María Fernanda Escamilla Rosales with account number 244926 of the Institute of Health Sciences of the UAEH.

References

Abbas, A. A., Bassey, A. E., Martins, A., Peter, U., & Terungwa, K. T. (2017). Antimicrobial activity of coconut oil and its derivative (Lauric acid) on some selected clinical isolates. International Journal of Medical Science and Clinical invention, 4, 3173-3177.

AOAC. (2019). Official Methods of Analysis of AOAC International. Gaithersburg, MD: AOAC.

Ariza-Ortega, J. A., López-Valdez, F., Montalvo-Paquini, C., Arellano-Huacuja, A., & Luna-Suárez, S. (2004). Desgomado y Neutralizado del aceite de amaranto. Revista de Ciencia y Tecnología de los Alimentos, 14, 28-32.

Badui, D. (2013). Química de alimentos. México: Pearson.

Bognár, A. (1998). Comparative study of frying to other cooking techniques influence on the nutritive value. Grasas y Aceites, 49, 250-260.

Brown, J., Vargo, S., Connor, E., & Nuckols. M. (1973). Causes of vertical stratification in the density of Cameraria hamadryadella. Ecological Entomology, 22(1), 16-25. doi.org/10.1046/j.1365-2311.1997.00046.x.

Conconi, M. (1993). Estudio comparativo de 42 especies de insectos comestibles con alimentos convencionales en sus valores nutritivo, calórico, proteínico y de aminoácidos haciendo énfasis en la aportación de los aminoácidos esenciales y su papel en el metabolismo humano. México: UNAM.

Cortés, P., Badillo, G., Segura, L., & Bouchon, P. (2014). Experimental evidence of water loss and oil uptake during simulated deep-fat frying using glass micromodels. Journal of Food Engineering, 140, 19-27. doi:10.1016/j.jfoodeng.2014.04.005.

Dana, D., & Saguy, S. (2006). Review: Mechanism of oil uptake during deep-fat frying and the surfactant effect-theory and myth. Advances in Colloid and Interface Science, 128(130), 267-72. doi:10.1016/j.cis.2006.11.013.

Ghosh, S., So-Min, L., Chuleui, J., & Meyer-Rochow, V. (2017). Nutritional composition of five commercial edible insects in South Korea. Asian Pacific Journal of Tropical Medicine, 20, 686-694. doi:10.1016/j.aspen.2017.04.003.

Jackson, M. A., & Eller, F. J. (2006). Isolation of long-chain aliphatic alcohols from beeswax using lipase-catalyzed methanolysis in supercritical carbon dioxide. Journal of Supercritical Fluids, 37, 173-177. doi: 10.1016/j.supflu.2005.08.008.

Juárez, M., & Sammán, N. (2010). El deterioro de los aceites durante la fritura. Revista Española de Nutrición Comunitaria, 13, 82-94.

Kusnezov, N. (1975). Numbers of species of ants in faune of differents latitudes. Evolution, 11(3), 298-299. doi.org/10.1111/j.1558-5646.1957.tb02898.x.

Ladrón de Guevara, O., Padilla, P., García, L., Pino, M. J. M., & Ramos-Elorduy, J. (1995). Amino acid determination in some edible Mexican insects. AminoAcids, 9, 161-173. doi: 10.1007/BF00805837.

Lara-Juárez, P., Aguirre, R. R. J., Castillo, L. P., & Reyes-Agüero, A. J. (2018). Recolección de pupas (escamoles) de *Liometopum apiculatum* (Hymenoptera, Formicidae, Dolichoderinae) en el altiplano de San Luis Potosí, México. INTERCIENCIA, 43(11), 763-769.

Melgar-Lalanne, G., Hernandez-Alvarez, A. J., & Salinas-Castro, A. (2019). Edible insects processing: Traditional and innovative technologies. Comprehensive Reviews in Food Science and Food Safety, 18, 1166-1191. doi.org/10.1111/1541-4337.12463.

Nagy, K., & Tiuca, I. D., 2017. Importance of fatty acids in physiopathology of human body. Retrieved from http://dx.doi.org/10.5772/67407.

NMX. (1994). Norma Mexicana (NOM-116-SSA1-1994). Determinación de humedad y materia volátil. México: SECOFI.

NMX. (2010). Norma Mexicana (NMX-F-154-SCFI-2010). Determinación del índice de peróxido. México: SECOFI.

NMX. (2011a). Norma Mexicana (NMX-F-152-SCFI-2011). Determinación del índice de yodo por el método de Wijs. México: SECOFI.

NMX. (2011b). Norma Mexicana (NMX-F-074-SCFI-2011). Determinación del índice de refracción con el refractómetro de Abbe. México: SECOFI.

NMX. (2011c). Norma Mexicana (NMX-F-014-SCFI-2011). Aceite comestible puro de coco. México: SECOFI.

NMX. (2012). Norma Mexicana (NMX-F-101-SCFI-2012). Determinación del índice de acidez. México: SECOFI.

NMX. (2018). Norma Mexicana (NMX-F-808-SCFI-2018). Aceite vegetal comestible. México: SECOFI.

Okparanta, S., Daminabo, V., & Solomon, L. (2018). Assessment of rancidity and other physicochemical properties of edible oils (Mustard and Corn Oils) stored at room temperature. Journal of Food and Nutrition Science, 6(3), 70-75. doi: 10.11648/j.jfns.20180603.11.

Orsavova, J., Misurcova, L., Vavra, A., Vicha, R., & MLcek, J. (2015). Fatty acids composition of vegetable oils and its contribution to dietary energy intake and dependence of cardiovascular mortality on dietary intake of fatty acids. International Journal of Molecular Sciences, 16, 12871-12890.

Raksakantong, P., Meeso, N., Kubola, J., & Siriamornpun, S. (2010). Fatty acids and proximate composition of eight Thai edible terricolous insects. Food Research International, 43, 350-355. doi.org/10.1016/j.foodres.2009.10.014.

Ramos-Elorduy, J. (2009). Anthropoentomophagy: Cultures, evolution and sustainability. Entomological Research, 39, 271-288. doi:10.1111/j.1748-5967.2009.00238.x.

Ramos-Elorduy, J. (2006). Threatened edible insects in Hidalgo, Mexico and some measures to preserve them. Journal Ethnobiology Ethnomedicine, 2(51). doi.org/10.1186/1746-4269-2-51.

Ramos-Elorduy, J., Pino, J., & Martínez, V. (2012). Could grasshoppers be a nutritive meal? Food and Nutrition Sciences, 3, 164-175. doi: 10.4236/fns.2012.32025 7,686.

Ramos-Elorduy, J., & Viejo, J. (2007). Los insectos como alimento humano: Breve ensayo sobre la entomofagia, con especial referencia a México. Real Sociedad Española de Historia Natural, 102(1-4), 61-84.

Rangaswamy, B. L., & Nasirullah. (2016). Effect of heat on physico-chemical and thermo-oxidative stability of repeatedly heated rice bran oil (RBO). International Journal of Food Nutrition Science, 5, 1-5.

Rivera, Y., Gutiérrez, C., Gómez, R., Matute, M., & Izaguirre, C. (2014). Cuantificación del deterioro de aceites vegetales usados en procesos de frituras en establecimientos ubicados en el Municipio Libertador del Estado Mérida. Ciencia e Ingeniería, 35(3), 157-164.

Rumpold, B. A., & Schlüter, O. (2013). Nutritional composition and safety aspects of edible insects. Molecular Nutrition & Food Research, 57, 802-823. doi: 10.1002/mnfr.201200735.

Sun, L., Feng, Y., & He, Z. (2007). Studies on alkaline solution extraction of polysaccharide from silkworm pupa and its immunomodulating activities. Forest Research, 20(6), 782-786.

Torres-Cifuentes, D., Cortés-Torres, C., & Ayala, A. (2015). Identificación de carbohidratos y lípidos y cuantificación de ácidos grasos de la larva de Ancognatha ustulata (Coleoptera: melolonthidae). Boletín de la Sociedad Entomológica Aragonesa, 56, 257-264.

Trillo, A. (2017). Adulteración de la cera de abeja. Problemática en su industrialización y comercialización. México: UNAM.

USDA (2018). United States Department of Agriculture. Retrieved from https://ndb.

ISSN-Internet 2197-411x OLCL 862804632

nal.usda.gov/ndb/foods/show/01145?fgcd=&manu=&format=&count=&max=25&offset=&sort=default&order=asc&qlookup=butter&ds=&qt=&qp=&qa=&qn=&q=&ing=Final del formularioNational Nutrient Database for Standard Reference.

Vilarrasa, E. (2014). Use of re-esterified oils in pig and broiler chicken diets. España: Universitat Autónoma de Barcelona.

Ying, L., Hanhan, L., Shumin, L., Sheng, W., Rong-Jing, J., & Sheng, L. (2009). Hormonal and nutritional regulation of insect fat body development and function. Archives of Insect Biochemistry and Physiology, 71, 16-30. doi:10.1002/arch.20290.

Yu, T. H., Wu, C. M., & Ho, C. T. (1993). Volatile compounds of deep-oil fried, microwave-heated and oven-baked garlic slices. Journal of Agricultural and Food Chemistry, 41, 800-805.

Zhang, Y., Wang, X., Wang, W., & Zhang, J. (2014). Effect of boiling and frying on nutritional value and in vitro digestibility of rabbit meat. African Journal of Food Science, 8(2), 92-103.

ISSN-Internet 2197-411x OLCL 862804632

Research Paper

Future of Food: Journal on Food, Agriculture and Society
9 (2) May 2021

Nutritional, antioxidant and polyphenol content of quinoa *(Chenopodium quinoa Willd.)* cultivated in Iran

SEYED SAEED SEKHAVATIZADEH[1*], SAEID HOSSEINZADEH[2], GHOLAMHOSSEIN MOHEBBI[3]

[1]Fars Agricultural and Natural Resources Research and Education Center, AREEO, Shiraz, Fars, Iran.
[2]Department of Food Hygiene and Public Health, School of Veterinary Medicine, Shiraz University, Shiraz, Iran.
[3]The Persian Gulf Marine Biotechnology Research Center, the Persian Gulf Biomedical Science Research Institute, Bushehr University of Medical Science, Bushehr, Iran.

* Corresponding author: s.sekhavati@areeo.ac.ir

Data of the article

First received : 25 September 2020 | Last revision received : 17 February 2021
Accepted : 01 May 2021| Published online :25 May 2021
DOI : 10.17170/kobra-202102163256

Keywords

Amino acid profile; Antioxidant activity; Quinoa; Vitamins and minerals

Quinoa is a pseudo cereal plant with high nutritional values. Recently, it was cultivated in Iran because of the water crisis. This study aimed to assess the physicochemical and antioxidant properties of quinoa cultivated in Iran for the first time. The macronutrients and energetic value, polyphenol, total phenol content and DPPH of quinoa were measured. Some B group vitamins, the free fatty acid profile and trace elements were assessed. Trace elements were also evaluated by ICP. The amounts of dry matter, protein, fat, ash, and available carbohydrates were, 90.30±0.89, 16.30±1.52, 6.09 ±0.30, 4.43±0.47, and 73.14±1.59 %, respectively. The total bacterial count of quinoa was 5.22±0.23 (LOG_{10} CFU/g). Escherichia coli and sulphite-reducing Clostridia were lower than 1.0 (LOG10 CFU/g). *Salmonella* was absent in all samples. According to the DPPH method, the half-maximal inhibitory concentration (IC_{50}) of quinoa seed was approximately 6232.0 mg/L compared to the equivalent Gallic acid as a standard (IC_{50}: 184.15 µg/mL). Quinoa seed contained the highest niacin level (0.881 mg/100g) among the vitamin B groups. The amino acid profile analysis revealed the highest contents of glutamic acid (1.230 g/100g) and lysine (3.08 g/100g). The linoleic acid content was 63.5 g/100g (fat). The concentrations of minerals including calcium, magnesium, and potassium, were 0.07, 0.086 and 0.35 g/100g $_{(dw)}$, respectively. Quinoa is a valuable nutritional product that can provide health benefits to humans, mainly because of its linoleic acid content.

1. Introduction

According to the World Bank definition, a geographic area concealing less than 1,700 m3 per capita of water is considered a most water-scarce region in the world. The Middle East and North Africa (MENA), which have an average of 1,274 m3 per capita, are included in these regions. Around 69.56 % of the nations in the MENA regions were reported to be suffering life-threatening water stress, i.e., less than 1,000 m3 per capita (Verdier, 2011). Few countries such as Iran, Iraq and Egypt are presently included in these critical areas. In general, nearly 80% of water is used in agriculture in the MENA region due to low irrigation efficiency (Negewo, 2012). Other important restrictions are water and soil salinity, which reduce the quality of crops and finally influence the crops' economic yield. Therefore, the quinoa plant is a valuable alternative crop because of its capability to lifecycle at 400 mM salinity (Hariadi et al., 2010). For this purpose, the

Iranian Ministry of Agriculture offers this plant as a substitute for water-intensive plants and provides facilities for its cultivation (Ranjbar et al., 2019).

Quinoa (Chenopodium quinoa Willd.) is a grain of the Chenopodiaceae family; it was a crop for the Incas who called it "the mother grain." It grows mainly in the Andean region of Colombia to northern Argentina, with Peru and Bolivia being the most important producers (Olivera-Montenegro et al., 2021).
However, it was unexplored in Middle East countries such as Iran (Konishi, 2002). Iran has great agricultural potentials for its vast area of arable land. However, climate changes and water resources insufficiencies are serious challenges to the Iranian agricultural and food production sectors. Altogether, 12% of land areas are under cultivation (arable land, orchards, and vineyards), but less than one-third of the cultivated area is irrigated; the rest is devoted to dry farming (Nanduri et al., 2019). The introduction of new crops and underutilised crops, especially those with higher water productivity and adapted to harsh conditions may be an option to tackle these challenges. It is expected that after five years, the cultivation of quinoa will reach 6,000 hectares in Iran. Quinoa is one of the few non-animal proteins from quantitative and qualitative opinion. It is believed that the quinoa protein is better than other cereals, and its content is twice as much as wheat and rice. Among the genotypes, Titicaca attained the highest yield (4.48 t/ha) in Iran (Bazile et al., 2016).

According to the literature, quinoa grain is considered a rich source of the lysine, methionine, and threonine; their essential amino acids are wealthier than conventional cereals (Lin et al., 2019), and the quality of animal proteins (Escudero et al., 2004). All essential amino acids have been found in quinoa, similar to those value of casein milk. Similar to wheat and rice, quinoa is an appropriate source of carbohydrates. One of the major components of quinoa is starch. The quinoa's dietary and soluble fibres are the same as conventional cereals such as wheat (James, 2009).

Quinoa's nutritional profile is comparable to major cereals and contains vitamins (thiamine, folic acid, vitamin C, α -carotene, and niacin) (Woomer & Adedeji, 2021). Fat content is another specific feature of the pseudo cereals; for instance, quinoa's lipid composition is substantially higher than that of the common cereals (Alvarez-Jubete et al., 2010). Their seeds contained the highest α-linolenic acid (ALA, 14C18:3 n-3) among all the pseudo cereals ranging from 385 to 473 g/kg of total fatty acid (Alvarez-Jubete et al., 2009; Jancurová et al., 2009). Quinoa contains higher linoleic acid (Omega-6) and other saturated fatty acids without compromising colour and texture when added to bread (Wang et al., 2015).

Quinoa is used in products such as salad, cakes, cookies and astronaut food because of its high nutritional value. In addition, it is suitable for diabetics, anaemia and lactose intolerance patients. Climatic conditions and the course of the weather are affecting the growth and nutritional value of quinoa. Titicaca is the species with the largest cultivation areas in Iran (Bazile et al., 2016; Sezgin & Sanlier, 2019). So far, little is known about trace substances of quinoa seed in Iran due to its limited cultivation. Therefore, this study was focused on the nutritional values, antioxidant activity, microbial properties and phenolic content of Titicaca seeds.

2. Materials and Methods

2.1. Chemicals

The chemicals, solvents, and standards including the hydrochloric acid, sodium 1-hexanesulfonate, methanol (HPLC grade), glacial acetic acid, gallic acid, catechin, chlorogenic acid, caffeic acid, quercetin, hesperedin, coumarin, p-coumaric acid, carvacrol, vanilin, trans-ferulic acid, sinapic acid, ellagic acid, hesperetin, eugenol, rosmarinic acid, thymol, and Folin–Ciocalteu phenol reagent and the other standard reagents were provided by Merck (Darmstadt, Germany). 1,1-diphenyl-2-picrylhydrazyl free radical (DPPH) was obtained from Sigma Chemicals Co. (St. Louis, USA). Gallic acid was provided by Acros Organics (New Jersey, USA).

2.2. Collection and further identification of seeds

Dried saponin-free quinoa (Chenopodium quinoa Willd.) was collected from growing plants in Koohenjan station, Sarvestan city, Fars province (South of Iran). Further identification of the plant was performed by the herbarium of the Fars Research Center for Agriculture and Natural Resources (FRCANR), Shiraz, Iran. A voucher specimen is deposited in the

herbarium of the FRCANR, Shiraz, Iran.

2.3. Macronutrients and energetic value

The samples were analysed for moisture, energetic values, and macronutrient contents (fat, ash, proteins and carbohydrates) according to the method described by AOAC (AOAC, 2016). The Macro-Kjeldahl method (6.25 for quinoa flour) (KjelFlex K-360, Büchi, Flawil, Switzerland) was employed to measure the protein. The Soxhlet apparatus was used to measure crude fat and to determine the ash content samples were incinerated at 550 ± 15 °C (Mariotti et al., 2008).

The following equations were used to evaluate total carbohydrates and energetic values according to (Bazile et al., 2016):

Total carbohydrates (g/100 g) =100– (m_{fat}+ m_{ash}+ $m_{proteins}$) (I);
Energy (kcal/100 g) =4× ($m_{proteins}$+ $m_{carbohydrates}$) +9× (m_{fat}) (I I) (Cardoso et al., 2019).

2.4. Microbiological analyses

The microorganisms *Salmonella, Coliforms, E. coli, Yeasts, Molds, Sulphite-reducing clostridia (SRC)* and Aerobic plate count (APC) were conducted in accordance with the Iranian National Standards (NO.11603) (Rahamifard et al., 2019).

2.5. Preparation of extract

The preparation and extraction methods were carried out based on Bahmanzadegan et al., 2019).

2.6. Extraction of polyphenol and HPLC analysis

Polyphenols were extracted according to the method given by Mišan et al. (2011) with some modifications. The chromatographic analysis was carried out using an autosampler HPLC Agilent 1200 series, equipped with a photodiode array detector (PDA), and a Zorbax Eclipse XDB-C18 column (4.6 × 5 µm i.d.; 150 mm film thickness (FT); 5µm. The elution was separately monitored at 320 and 280 nm for chlorogenic acid and the other polyphenols. Linear calibration graphs were obtained with an acceptable correlation for standard solutions (Mišan et al., 2011).

2.7. Total phenolic content analysis

Total polyphenols content (TPC) was quantified using Folin–Ciocalteu reagent (Ainsworth & Gillespie, 2007). The aqueous extract was also added to the Folin–Ciocalteu reagent in the presence of sodium carbonate anhydrous, creating a dark blue solution. Then, the absorbance was measured at 765 nm to obtain the total phenolic content using the Gallic acid calibration curve as the standard (Mišan et al., 2011).

2.8. Evaluation of antioxidant activity by DPPH methods

The extracts' antioxidant activity was spectrophotometrically measured using an ELx808 microplate reader (BioTek Instruments Inc., Winooski, VT, USA), by monitoring the disappearance of DPPH at 517 nm, according to the described procedure. The antiradical activity was expressed based on the number of antioxidants, necessary to decrease the initial DPPH absorbance by 50 % (IC50) which was then calculated from the nonlinear regression curve of Log (concentration of the test extract g/ml) against the mean values of the radical scavenging activity (Bahmanzadegan et al., 2019).

2.9. Determination of vitamins (thiamine, riboflavin, niacin)

The concentrations of thiamine, riboflavin, niacin were measured using HPLC Shimadzu LC (Kyoto, Japan) equipped with a UV detector. The Sample preparation and analysis were done based on Anyakora et al. (2008) and the Iranian National Standard (NO. 5333). Samples were extracted by acid hydrolysis. The separation was carried out using a Supelco column C-18 (x 25 cm, 4.6mm, ODS), 30 °C, with a flow rate of 1.0 mL/min in HPLC, the vitamin content was expressed as mg/100g d. m (Anyakora et al., 2008; Farrahi et al., 2001).

2.10. Folic acid

The folic acid analysis was performed after hydrolysis of seed samples based on Qureshi et al. (2005). The separation was carried out using a Supelco column C-18 (x 25 cm, 4.6mm, ODS), 30 °C, with a flow rate of 1.0 mL/min in HPLC, Shimadzu LC (Kyoto, Japan) equipped with a UV detector (SPD-A series) with de-

ISSN-Internet 2197-411x OLCL 862804632

tection at λ = 245 nm. The folic acid content was expressed as mg in (100g d/m) (Qureshi et al., 2005).

2.11. Amino acid composition

The amino acid analysis was performed after hydrolysis of seed samples based on protocols of the U.S. Pharmacopeia. The separation was carried out using a 4 mm x 25 cm with precolumn (PS Spheribond 80-5 ODS 2), AK351, Vertex Plus column, 40 °C, with a flow rate of 1.0 mL/min in HPLC, Shimadzu LC (Kyoto, Japan) equipped with a fluorescence detector (RF-20A series) at λ excitation 348nm and λ emission 450 nm. The amino acid content was expressed in mg/100g (d.m). For lysin analysis HPLC system an autosampler system (Perkin Elmer, Australia) was used with the same procedure (United States Pharmacopeia, 2017).

2.12. The free fatty acid profile

The n-hexane extract of the sample was placed at a temperature of -40 °C for stability and freeze-dried for 24 hours by freeze-dryer FD-5003-BT, Dena vacuum, (Iran). The free fatty acid analysis was carried out using a 7890B GC System (Agilent Technologies, Santa Clara, USA). The components were separated on HP-5ms column (30 m _ 0.25 mm i.d., 0.25- Agilent 19091s-443) based on Pastor et al. (2020).

2.13. Determination of trace elements

In order to analyse the total values of Ag, Ba, Co, Ga, Mg, Ni, Zn, T1, A1, Bi, Cr, In, Mn P, Sr, V, As, Ca, Cu, K, Mo, Pb, Sn, B, Cd, Fe, Li, Na and Sb, an inductively coupled plasma-optical emission spectrometry (ICP OES, model iCAP 6000, Thermo Fisher Scientific, Madison, WI, USA) was used after acid digestion and treatment in the quinoa sample. Concentration in the sample was measured according to the USA EPA method 3050 (Zhang & Lin, 2019).

3. Results and Discussion

3.1. Macronutrients and Energetic Value

Details of the physicochemical parameters are summarised in Table 1. Quinoa flour has a higher protein content than corn or rice flours. It has higher contents of certain amino acids such as lysine (710 mg/100 g vs 141 and 194 mg/100 g in corn and rice flours, respectively) and aspartic acid (1160 mg/100g vs 400 and 758 mg/100 g, respectively) (Jancurová et al., 2009). The protein content of 14.8 % and 15.7 % respectively for sweet and bitter quinoa, from Bolivia, was reported by Wright et al. (2002). A protein range of 9.1% -15.5% was also considered for 11 genotypes of quinoa (González et al., 2012). In similar research, the cultivar BRS Alegria showed a crude protein level (20.92 ± 0.23%) which was a greater value than obtained in this study (16.30±1.52) (Palombini et al., 2013). Therefore, the cultivar and nitrogen source may affect protein content (Miranda et al., 2011). Previous research has established that the crude fat, carbohydrate, and ash were (4.48+0.32, 63.58+1.25 and 3.1+0.43), respectively. These results are not in agreement with the findings of this research. One reason for this difference could be related to quinoa varieties (Marmouzi et al., 2015).

The pH value is an important factor to detect the treatment strategy supplied to the flour if it shows excessive alteration as in the case of chlorine bleaching. It is also considered as a significant factor in the capacity of microorganisms to develop in foodstuff. A lower pH value (less than 5.5) is mainly caused by contaminated flour with some live yeast or other bacteria due to the excess biological activity (Souza et al., 2008). High levels of moisture can provide a proper environment for microorganisms' growth and is a critical factor in mycotoxin production (Hădărugă et al., 2016). The moisture of quinoa was about 3.66 %. As a result, a low moisture level is always advantageous for a longer shelf-life of a product.

3.2. Microbiological analyses

Table (1) illustrates the results of microbiological counts in the quinoa. The APC microorganisms acquired in the present study for the quinoa flours were greater than other results (Eglezos, 2010; Cardoso et al., 2019), respectively, reported values of 4.2 and 4.44 LOG10 CFU/g for wheat. The cereal grains are commonly susceptible to contamination during various stages of ripening, harvesting, processing, and storage. The constant contaminants of grain flours are microorganisms because they originate from the cereals vegetation period as they are an integral part of the grain mass. Such microorganisms are less active un-

der unfavourable conditions and are not considered potential hazards (Cardoso et al., 2019).

3.3. Polyphenol, total phenol and antioxidant activity

The quantitative analysis of quinoa has revealed six phenolic compounds in the methanolic extract (Table 2 and Fig 1), and consequently, a high IC50 about 6232.0 mg/L compared to equivalent Gallic acid as a standard (IC50: 184.15 µg/mL). Total phenolic content was also reported at 8.298 mg/g dwequivalent Gallic acid. In previous studies by Marmouzi et al. (2015) phenolic content of quinoa was higher (20.63 mg/g dw) than our results. One reason for this difference may be associated with genetic and environmental conditions, which can influence the presence of phenolic compounds. Phenolic content is responsible for antioxidant activity. However, numerous discrepancies have resulted from a lack of standardised extraction methods, an issue previously addressed in the literature (Marmouzi et al., 2015). In the last

Table 1. Proximate and microbiological analyses of quinoa seed

Parameters	Quinoa seed	***Microorganisms analysed	Quinoa seed
pH	4.96±0.02	[c]APC $_{(LOG10\ ^{c}CFU/g)}$	5.22±0.23
Acidity	9.67±0.33	*Coliforms* $_{(LOG10\ CFU/g)}$	2.47±0.14
Dry matter (g/100 g as fed)	90.30±0.89	*Yeasts* $_{(LOG10\ CFU/g)}$	2.39±0.21
protein (g/100 g dw)	16.30±1.52	*Molds* $_{(LOG10\ CFU/g)}$	2.31±0.28
fat (g/100 g dw)	6.09±0.30	*Escherichia coli* $_{(LOG10\ CFU/g)}$	<1.0
ash (g/100 g dw)	4.43±0.47	[c]SRC $_{(LOG10\ CFU/g)}$	<1.0
[a]carbohydrates (g/100 g dw)	73.14±1.59	*Salmonella spp.* $_{(LOG10\ CFU/g)}$	Absent
[b]Energy (kcal/100 g dw)	412.73±0.70		

Values are expressed as mean ± SD; dw: Dry weight

[a] Total carbohydrates (g/100 g) =100− (m_{fat}+ m_{ash}+ $m_{proteins}$)

[b] Energy =4× (% protein + %carbohydrates) + 9× (% fat)

Table 2 Polyphenol content of quinoa seed

Polyphenol content	**quinoa extract (mg.L^{-1})**	**Retention time (min)**
Sinapic acid	ND[a]	16.5
Gallic acid	51.75007	3.3
Catechin	ND	8.3
Caffeic acid	0.264	11.6
Chloregenic acid	ND	10.5
Quercetin	ND	21.6
p-Coumaric acid	1.890197	15.6
Coumarin	ND	17.4
Carvacrol	ND	28.4
Vanilin	6.27276	13.5
Trans-ferulic acid	27.2985	16.3
Hesperedin	13.36627	18.5
Ellagic acid	ND	19.02
Eugenol	ND	23.7

ISSN-Internet 2197-411x OLCL 862804632

decade, more attention has been paid to naturally occurring antioxidants to inhibit both free radical function and oxidative chain reactions within tissues and membranes (Nsimba et al., 2008). Antioxidants can effectively delay or inhibit the oxidation of lipids and other macromolecules. They can delay or inhibit the initiation stage of fat oxidising chain reactions. Therefore, the rancidity of foods decreases the formation of toxic products but increase shelf life. The presence of antioxidants in food makes it more valuable (Paśko et al., 2009). In this research, the IC50 of quinoa seed was 6232.0 mg/L. The pseudo-cereal seeds and sprout revealed relatively high antioxidant activities (Paśko et al., 2009). Abderrahim et al. (2015) evaluated the antioxidant activities of various extracts of quinoa (Japan) and from its relative Amaranthus, finding different values among the samples (Abderrahim et al., 2015). In other research, IC50 of quinoa was (461.89 mg/L) lower than our result. The different ecotypes of quinoa, presented IC50 values between 100-15800 mg/L. Data variation in the antioxidant capacity of quinoa ecotypes is expected, as many factors such as genetic, agrotechnical processes and environmental conditions can influence the presence of phenolic compounds (Miranda et al., 2011).

Over 20 phenolic compounds have been found in both free and conjugated forms (mainly liberated by alkaline, acid, and enzymatic hydrolysis). Vanillic acids, ferulic acids, and their derivatives, as well as the flavonoids quercetin, kaempferol, and their glycosides, are among the most common phenolic acids compounds (Tang et al., 2015; Tang et al., 2016). Apart from their antioxidant activities, they utilise α-glucosidase and inhibit pancreatic lipase function (Tang et al., 2016). The plant is mainly associated with phytoecdysteroids (polyhydroxylated steroids) because their structure is related to insect-moulting hormones. Wide ranges of beneficial effects such as anabolic, performance-enhancing, anti-osteoporotic, anti-diabetic, anti-obesity, and wound healing properties, have been demonstrated for these components (Graf et al., 2014).

3.5. Group B vitamins

Table (3) shows some B vitamins measured in quinoa. Mohyuddin et al. (2019) have reported appreciable amounts of thiamine and folic acid (respectively, 0.4, and 78.1 mg.100 g–1). Other researchers report B vitamin quantities as follows: thiamine (vitamin B1) (0.4 mg/100g), riboflavin (vitamin B2) (0.39 mg/100g), niacin (vitamin B3) (1.06 mg/100g) and folic acid (vitamin B9) (112 µg/100 g) (Graf et al., 2015). Miranda et al. (2012) reported significant differences in the vitamin B contents in grain due to variety, growing location (for thiamine and riboflavin) and soil type. It was shown that quinoa contains substantially more riboflavin (B2) than those cereals. Thiamine values in quinoa are lower than those in oat or barley, but not higher than those of niacin, riboflavin, vitamin B6 and total folate (James, 2009). Surprisingly, the levels folic acid in 100 g of quinoa is reported to meet the adult daily requirement, while riboflavin meets 80% of children's needs and 40% of adult daily prerequisites (James, 2009).

3.6. Amino acids

Table (3) and Fig (1) show some amino acid measured in quinoa. In this research, the highest concentrations belonged to lysin and glutamic acid, followed by aspartic acid, asparagine serin and arginine. These results are different from the findings of Escuredo et al. (2015). The variability could be due to diverse quinoa genotypes and growth years, both in the calibration and external validation sets, which was important for developing calibration equations for future predictions (Escuredo et al., 2014).

According to the values indicated by FAO/WHO/UNU, quinoa protein can supply around 180% isoleucine, 338% lysine, 212% methionine+cysteine, 320% phenylalanine+tyrosine, 331% threonine, 228% tryptophan and 323% valine of the suggested amounts in protein sources for adult nutrition. Besides, cysteine and methionine, the sulphur-containing amino acids, are present at high concentrations than other plants (James, 2009). Quinoa proteins are particularly high in lysine, the limiting amino acid in most cereal grains. Lysine and leucine in quinoa proteins are limiting amino acids for 2–5-year-old infants or children, while all the essential amino acids of this protein are sufficient according to FAO/WHO (James, 2009).

3.7. Free fatty acid profile

Fat content in quinoa ranged from 1.8 to 9.5 g/100g(dw), with an average of 5.0–7.2 g/100g(dw).

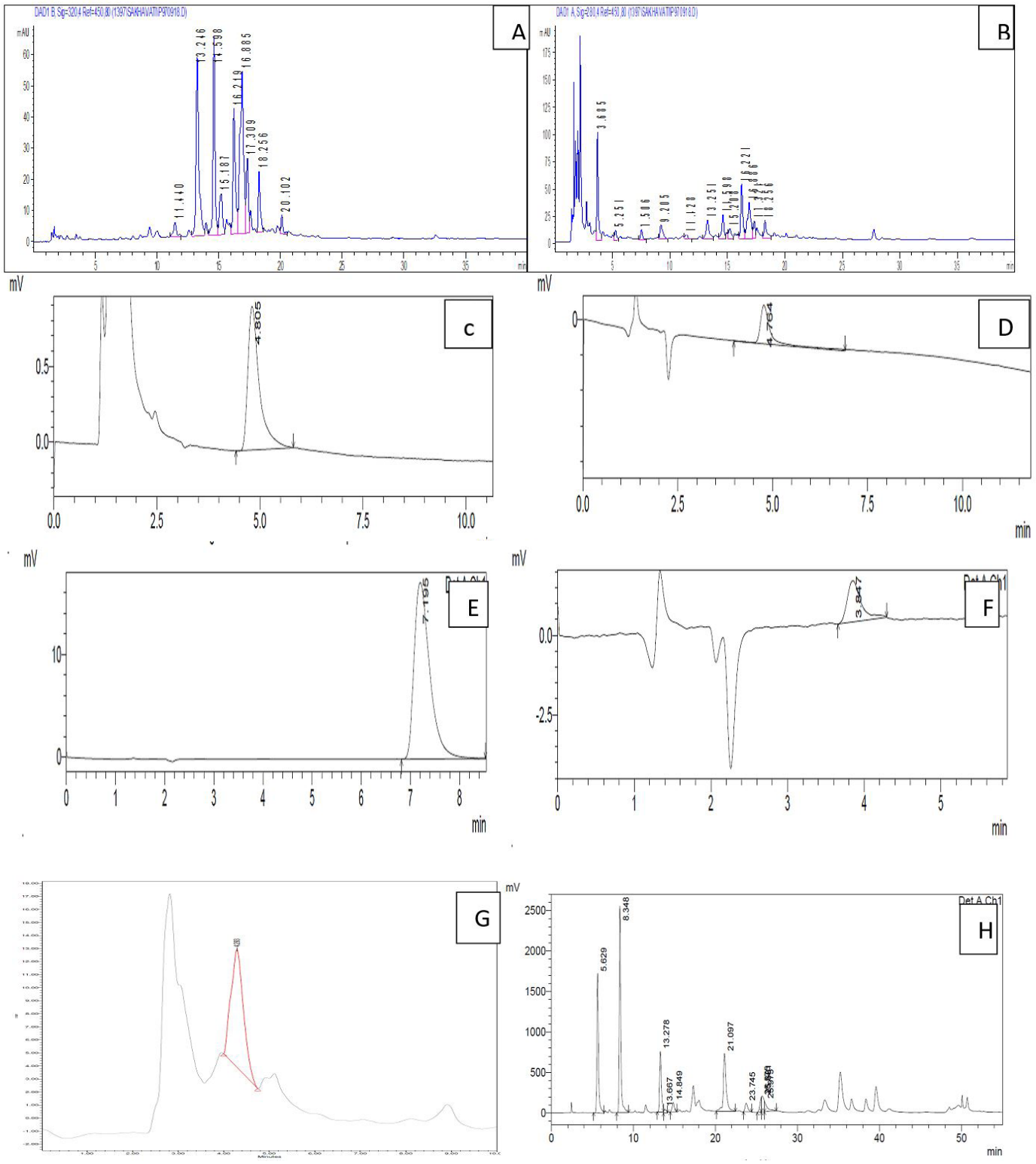


Fig 1. High-performance liquid chromatograms of the A: methanolic extract of quinoa seeds (280 nm), B: (320 nm), C: Riboflavin, D: Niacin, E: Folic acid, F: Thiamin, G: Lysin and H: Amino acids UV–visible spectrum

Table (3) shows some free fatty acid measured in quinoa. In this study, the majority of the fatty acids in quinoa seeds were unsaturated fatty acids (UFA). Approximately two-thirds were polyunsaturated fatty acids (PUFA), and one-third were monounsaturated fatty acids (MUFA). These results are similar to those reported by Tang et al. (2015). PUFA were

ISSN-Internet 2197-411x OLCL 862804632

mainly from two essential fatty acids, linoleic acid (18:2n6, an omega-6 fatty acid) and a-linolenic acid (18:3n3, an omega-3 fatty acid) (Tang et al., 2015). Linoleic acid impacts the risk of many chronic diseases, including cardiovascular diseases, certain cancers and Type 2 diabetes (Belury et al., 2018). Some fatty acids in quinoa are saturated (11 g/100g(dw fat)), while (88.31 g/100g(dw fat)) of the total fatty acids of quinoa is an unsaturated fatty acid. Similar levels of linoleic (C18:2), oleic (C18:1), and alpha-linolenic (C18:3) were recorded with corn and soybeans. These fatty acids equal nearly 88 g/100g(dw) of the total fatty acid amount of quinoa seeds (Navruz-Varli & Sanlier, 2016; Repo-Carrasco et al., 2003). The role of α-linolenic acid in preventing many degenerative diseases such as cardiovascular disease, cancer, osteoporosis, inflammatory and autoimmune diseases is well-established (Simopoulos, 2006). Furthermore, palmitic fatty acid, which exists in quinoa as a basic saturated fatty acid, constitutes 10 g/100g(dw) of its total fatty acids. From among unsaturated fatty acids, oleic (19.7-29.5 g/100g(dw)), linoleic (49.0-56.4 g/100g(dw)) and alpha-linolenic (8.7-11.7 g/100g(dw)) fatty acids constitute 87.2-87.8 g/100g(dw) of its total fatty acids in a similar way to soybean lipid composition (Repo-Carrasco et al., 2003; Navruz-Varli & Sanlier, 2016).

3.8. Minerals

Analysis of the trace elements is demonstrated in Table (4). High contents of calcium (0.07 g/100 g), magnesium (0.086 g/100 g) and iron (0.043 g/100 g) were reported in quinoa seeds, which is also of significant importance (Repo-Carrasco et al., 2003). Many of these minerals are present in higher concentrations compared to other common grains. Moreover, calcium, magnesium, and potassium found in quinoa can be absorbed and used by the body (bioavailable forms); thus, their contents are considered as adequate for a balanced diet (Vega-Gálvez et al., 2010). Phosphorus, along with calcium, is one of the most important minerals in the development and maintenance of skeletal tissue in animals. About 80% of phosphorus in the animal body is found in bones and teeth. Potassium deficiency is rare in animals; it can occur in high-level fattening cattle fed with concentrated feed. On the other hand, an excess of this mineral reduces the absorption and evaluation of magnesium (Tan, 2020).Variations in the mineral concentrations of quinoa are possibly associated with the soil type, mineral composition of the geographic region and the application of a specific fertiliser (Belton & Taylor, 2002).

4. Conclusion

Quinoa (Chenopodium quinoa Willd.) is an appealing food because of its nutritional characteristics, the high value of energy and therapeutic effects, as well as the absence of gluten. It is a good source of protein, carbohydrate, essential minerals and B vitamins. The protein quality of quinoa, mainly by its exceptional amino acid balance, makes it a more beneficial food than many common vegetables. The oil fraction of the seeds represents the high quality and high nutritional value (linoleic acid). It is also rich in iron and magnesium, phosphorus, potassium, and some B vitamins. All nutritional factors make it an attractive, novel protein source that could be used alone or combined with cereal grains.

Conflict of interest

The authors declare no conflict of interest. Besides, the funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

Acknowledgement

The authors thank Dr. Ebrahim Zare for his assistance during the research. This study did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

Abderrahim, F., Huanatico, E., Segura, R., Arribas, S., Gonzalez, M. C., & Condezo-Hoyos, L. (2015). Physical features, phenolic compounds, betalains and total antioxidant capacity of coloured quinoa seeds (Chenopodium quinoa Willd) from Peruvian Altiplano. Food Chemistry, 183, 83-90.

Alvarez-Jubete, L., Arendt, E., & Gallagher, E. (2009). Nutritive value and chemical composition of pseudocereals as gluten-free ingredients. International Journal of Food Sciences and Nutrition, 60(sup4),

Table 3. Amino acids, vitamins and Free fatty acid profile in quinoa seeds present in quinoa seed

Amino acids (gr/100g)		Free fatty acid ($g r / 100 g_{fat}$)		Vitamin(mgr/100g)	
Aspartic acid	0.8141	Eicosenic acid	1.03	Thiamin	0.486
Glutamic acid	1.230	Linoleic acid	63.5	Riboflavin	0.572
Asparagine	0.4205	Oleic acid	18.46	Niacin	0.881
Serine	0.6612	Palmitic acid	11.24	Folic acid	0.097
Glutamine	0.0955	unknown	0.33		
Tyrosine	0.3981	Linolenic acid	5.32		
Arginine	0.6383	Σ Saturated fatty acid (SFA)	11.57		
Methionine	0.0878	Σ Unsaturated fatty acid (UFA)	88.31		
Tryptophan	0.2107	Σ Monounsaturated fatty acid (MUFA)	19.41		
Valine	0.2405	Σ Polyunsaturated fatty acid (PUFA)	68.82		
Isoleucine	0.5216				
Lysin	3.0829				

Table 4 Analysis of quinoa seed trace elements

Element	Measure (g/100g)	Element	Measure (g/100g)	Element	Measure (g/100g)	Element	Measure (g/100g)
Ag	>0.001	Al	0.005	As	>0.001	B	>0.001
Ba	>0.001	Bi	>0.001	Ca	0.07	Cd	>0.001
Co	>0.001	Cr	>0.001	Cu	>0.001	Fe	0.043
Ga	>0.001	In	>0.001	K	0.35	Li	>0.001
Mg	0.086	Mn	0.006	Mo	>0.001	Na	0.095
Ni	>0.001	P	0.12	Pb	>0.001	Sb	>0.001
Zn	>0.001	Sr	>0.001	Sn	>0.001	Ti	>0.001
Ti	>0.001	V	>0.001				

240-257.

Alvarez-Jubete, L., Arendt, E., & Gallagher, E. (2010). Nutritive value of pseudocereals and their increasing use as functional gluten-free ingredients. Trends in Food Science & Technology, 21(2), 106-113.

Anyakora, C., Afolami, I., Ehianeta, T., & Onwumere, F. (2008). HPLC analysis of nicotinamide, pyridoxine, riboflavin and thiamin in some selected food products in Nigeria. African Journal of Pharmacy and Pharmacology, 2(2), 029-036.

ISSN-Internet 2197-411x OLCL 862804632

Bahmanzadegan, A., Rowshan, V., Zareiyan, F., & Hatami, A. (2019). Lagoecia cuminoides L., its antioxidant activity and polyphenolic constituents from Iran. Natural Product Research, 33(16), 2376-2378.

Bazile, D., Pulvento, C., Verniau, A., Al-Nusairi, M. S., Ba, D., Breidy, J., . . . Otambekova, M. (2016). Worldwide evaluations of quinoa: preliminary results from post international year of quinoa FAO projects in nine countries. Frontiers in Plant Science, 7, 850.

Belton, P. S., & Taylor, J. R. (Eds.). (2002). Pseudocereals and less common cereals: grain properties and utilisation potential.Verlag Berlin, Germany: Springer Science & Business Media.

Belury, M. A., Cole, R. M., Snoke, D. B., Banh, T., & Angelotti, A. (2018). Linoleic acid, glycemic control and Type 2 diabetes. Prostaglandins, Leukotrienes and Essential Fatty Acids, 132, 30-33.

Cardoso, R. V., Fernandes, Â., Heleno, S. A., Rodrigues, P., Gonzaléz-Paramás, A. M., Barros, L., & Ferreira, I. C. J. F. c. (2019). Physicochemical characterisation and microbiology of wheat and rye flours. Food Chemistry, 280, 123-129.

Eglezos, S. (2010). Microbiological quality of wheat grain and flour from two mills in Queensland, Australia. Journal of Food Protection, 73(8), 1533-1536.

Escudero, N., De Arellano, M., Luco, J., Giménez, M., & Mucciarelli, S. (2004). Comparison of the chemical composition and nutritional value of Amaranthus cruentus flour and its protein concentrate. Plant Foods for Human Nutrition, 59(1), 15-21.

Escuredo, O., Martín, M. I. G., Moncada, G. W., Fischer, S., & Hierro, J. M. H. (2014). Amino acid profile of the quinoa (Chenopodium quinoa Willd.) using near infrared spectroscopy and chemometric techniques. Journal of Cereal Science, 60(1), 67-74.

Farrahi, F., Hajseyedjavadi, S. A., Behfar, A., & Irani, V. (2001). Determination of thiamin, Riboflavin, Pyridoxin, niacin, and folic acid in dry vitamin supplements by high performance liquid chromatography (HPLC). Institute of Standards and Industrial Research of Iran, 1st ed. Retrieved from http://standard.isiri.gov.ir/StandardView.aspx?Id=89

González, J. A., Konishi, Y., Bruno, M., Valoy, M., & Prado, F. E. (2012). Interrelationships among seed yield, total protein and amino acid composition of ten quinoa (Chenopodium quinoa) cultivars from two different agroecological regions. Journal of the Science of Food and Agriculture, 92(6), 1222-1229.

Graf, B. L., Poulev, A., Kuhn, P., Grace, M. H., Lila, M. A., & Raskin, I. (2014). Quinoa seeds leach phytoecdysteroids and other compounds with anti-diabetic properties. Food Chemistry, 163, 178-185.

Graf, B. L., Rojas-Silva, P., Rojo, L. E., Delatorre-Herrera, J., Baldeón, M. E., & Raskin, I. (2015). Innovations in health value and functional food development of quinoa (Chenopodium quinoa Willd). Comprehensive Reviews in Food Science and Food Safety, 14(4), 431-445

Hădărugă, D. I., Costescu, C. I., Corpaş, L., Hădărugă, N. G., & Isengard, H.-D. (2016). Differentiation of rye and wheat flour as well as mixtures by using the kinetics of Karl Fischer water titration. Food Chemistry, 195, 49-55.

Hariadi, Y., Marandon, K., Tian, Y., Jacobsen, S.-E., & Shabala, S. (2010). Ionic and osmotic relations in quinoa (Chenopodium quinoa Willd.) plants grown at various salinity levels. Journal of Experimental Botany, 62(1), 185-193.

James, L. E. A. (2009). Quinoa (Chenopodium quinoa Willd): composition, chemistry, nutritional, and functional properties. Advances in Food and Nutrition Research, 58, 1-31.

Jancurová, M., Minarovičová, L., & Dandar, A. (2009). Quinoa–a rewiev. Czech Journal of Food Sciences, 27(2), 71-79

Konishi, Y. (2002). Nutritional characteristics of pseudocereal amaranth and quinoa: alternative foodstuff for patients with food allergy. Journal of Japan Society of Nutritionand Food Sciences, 55, 299-302.

Lin, M., Han, P., Li, Y., Wang, W., Lai, D., & Zhou, L. (2019). Quinoa secondary metabolites and their

biological activities or functions. Molecules, 24(13), 2512.

Mariotti, F., Tomé, D., & Mirand, P. P. (2008). Converting nitrogen into protein—beyond 6.25 and Jones' factors. Critical Reviews in Food Science and Nutrition, 48(2), 177-184.

Marmouzi, I., El Madani, N., Charrouf, Z., Cherrah, Y., & Faouzi, M. E. A. (2015). Proximate analysis, fatty acids and mineral composition of processed Moroccan Chenopodium quinoa Willd. and antioxidant properties according to the polarity. Phytothérapie, 13(2), 110-117.

Mišan, A. Č., Mimica-Dukić, N. M., Mandić, A. I., Sakač, M. B., Milovanović, I. L., & Sedej, I. J. (2011). Development of a rapid resolution HPLC method for the separation and determination of 17 phenolic compounds in crude plant extracts. Central European Journal of Chemistry, 9(1), 133-142.

Miranda, M., Vega-Gálvez, A., Uribe, E., López, J., Martínez, E., Rodríguez, M. J., . . . Di Scala, K. (2011). Physico-chemical analysis, antioxidant capacity and vitamins of six ecotypes of Chilean quinoa (Chenopodium quinoa Willd.). Procedia Food Science, 1, 1439-1446.

Miranda, M., Vega-Gálvez, A., Quispe-Fuentes, I., Rodríguez, M. J., Maureira, H., & Martínez, E. A. (2012). Nutritional aspects of six quinoa (Chenopodium quinoa Willd.) ecotypes from three geographical areas of Chile. Chilean Journal of Agricultural Research, 72(2), 175.

Mohyuddin, S. G., Riaz, A., Qamar, A., Ali, S. H., Hu, C., Wu, L., ... & Ju, X. H. (2019). Quinoa is beneficial to the comprehensive nutritional value of potential health. Pakistan Journal of Science, 71(2), 69-74.

Nanduri, K. R., Hirich, A., Salehi, M., Saadat, S., & Jacobsen, S. E. (2019). Quinoa: A New Crop for Harsh Environments (Eds., Gul,B., Böer, B., Khan, M.A., Clüsener-Godt, M and Hameed, A), Tasks for Vegetation Science (pp. 301-335). Cham, Switzerland: Springer Nature Switzerland.

Navruz-Varli, S., & Sanlier, N. (2016). Nutritional and health benefits of quinoa (Chenopodium quinoa Willd). Journal of Cereal Science, 69, 371-376.

Negewo, B. D. (2012). Renewable energy desalination: an emerging solution to close the water gap in the Middle East and North Africa: Washington, D.C, USA: World Bank Publications.

Nsimba, R. Y., Kikuzaki, H., & Konishi, Y. (2008). Antioxidant activity of various extracts and fractions of Chenopodium quinoa and Amaranthus spp. seeds. Food Chemistry, 106(2), 760-766. Olivera-Montenegro, L., Best, I., & Gil-Saldarriaga, A. (2021). Effect of pretreatment by supercritical fluids on antioxidant activity of protein hydrolyzate from quinoa (Chenopodium quinoa Willd.). Food Science & Nutrition, 9(1), 574-582.

Palombini, S. V., Claus, T., Maruyama, S. A., Gohara, A. K., Souza, A. H. P., Souza, N. E. D., . . . Matsushita, M. (2013). Evaluation of nutritional compounds in new amaranth and quinoa cultivars. Food Science and Technology, 33(2), 339-344.

Paśko, P., Bartoń, H., Zagrodzki, P., Gorinstein, S., Fołta, M., & Zachwieja, Z. (2009). Anthocyanins, total polyphenols and antioxidant activity in amaranth and quinoa seeds and sprouts during their growth. Food Chemistry, 115(3), 994-998.

Pastor, K., Ilić, M., Vujić, D., Jovanović, D., & Ačanski, M. (2020). Characterisation of fatty acids in cereals and oilseeds from the republic of Serbia by gas chromatography–mass spectrometry (GC/MS) with hemometrics. Analytical Letters, 53(8), 1177-1189.

Qureshi, Q., Jamil, M., & Mateen, A. (2005). Simultaneous determination of orotic acid and folic acid in pure forms and in pharmaceuticals formulations by HPLC. Pakistan Journal of Analytical & Environmental Chemistry, 6(1), 28-32.

Rahamifard, N., Fayazi, A. S., Amirahmadi, S. S., Jabari, M., Delavari, H., Zamani, S., Saadati, S., Sharafi, G., Keshavarz, R. & Mohammadi, A. (2019). Microbiological of grains cereal and pulses specifications and test method. National Standard No. 11603.

Ranjbar, G. H., Dehghani, F., Banakar, M. H.,

ISSN-Internet 2197-411x OLCL 862804632

Hasheminejad, Y., & Rahimian, M. H. (2019). Instructions of the Salinity Institute, Edited by National Salinity Research Center, Yazd, Iran. Retrieved from : ttp://www.areeo.ac.ir/_DouranPortal/Documents/%D8%B4%D9%88%D8%B1%DB%8C%20%D9%86%D9%87%D8%A7%DB%8C%DB%8C%20%DA%86%D8%A7%D9%BE_20200502_124124_20200512_102317.pdf

Repo-Carrasco, R., Espinoza, C., & Jacobsen, S.-E. (2003). Nutritional value and use of the Andean crops quinoa (Chenopodium quinoa) and kañiwa (Chenopodium pallidicaule). Food Reviews International, 19(1-2), 179-189.

Sezgin, A. C., & Sanlier, N. (2019). A New Generation Plant For The Conventional Cuisine: Quinoa (Chenopodium Quinoa Willd). Trends in Food Science & Technology.

Simopoulos, A. P. (2006). Evolutionary aspects of diet, the omega-6/omega-3 ratio and genetic variation: nutritional implications for chronic diseases. Biomedicine & Pharmacotherapy, 60(9), 502-507.

Souza, J. M. L. d., Álvares, V. d. S., Leite, F. M. N., Reis, F. S., & Felisberto, F. Á. V. (2008). Physicochemical characteristics of flours deriving of cassava varieties used in the Vale do Juruá, Acre. Acta Amazonica, 38(4), 761-766.

Tan, M. (2020). Macro-and micromineral contents of different quinoa (Chenopodium quinoa Willd.) varieties used as forage by cattle. Turkish Journal of Agriculture and Forestry, 44(1), 46-53.

Tang, Y., Li, X., Chen, P. X., Zhang, B., Hernandez, M., Zhang, H., . . . Tsao, R. (2015). Characterisation of fatty acid, carotenoid, tocopherol/tocotrienol compositions and antioxidant activities in seeds of three Chenopodium quinoa Willdgenotypes. Food Chemistry, 174, 502-508.

Tang, Y., Zhang, B., Li, X., Chen, P. X., Zhang, H., Liu, R., & Tsao, R. (2016). Bound phenolics of quinoa seeds released by acid, alkaline, and enzymatic treatments and their antioxidant and α-glucosidase and pancreatic lipase inhibitory effects. Journal of Agricultural and Food Chemistry, 64(8), 1712-1719.

United States Pharmacopeia. (2017). The United States Pharmacopeial Convention, 1052 Rockville Biotechnology-Derived Articles—Amino Acid Analysis.

Vega-Gálvez, A., Miranda, M., Vergara, J., Uribe, E., Puente, L., & Martínez, E. A. (2010). Nutrition facts and functional potential of quinoa (Chenopodium quinoa Willd), an ancient Andean grain: a review. Journal of the Science of Food and Agriculture, 90(15), 2541-2547.

Verdier, F. (2011). MENA regional water outlook part II desalination using renewable Energy task 1–desalination potential. Fichtner Stuttgart.

Wang, S., Opassathavorn, A., & Zhu, F. (2015). Influence of quinoa flour on quality characteristics of cookie, bread and Chinese steamed bread. Journal of Texture Studies, 46(4), 281-292.

Woomer, J. S., & Adedeji, A. A. (2021). Current applications of gluten-free grains–a review. Critical Reviews in Food Science and Nutrition, 61(1), 14-24.

Wright, K., Pike, O., Fairbanks, D., & Huber, C. (2002). Composition of Atriplex hortensis, sweet and bitter Chenopodium quinoa seeds. Journal of Food Science, 67(4), 1383-1385.

Zhang, W. J., & Lin, M. F. (2020). Influence of redox potential on leaching behavior of a solidified chromium contaminated soil. Science of the Total Environment, 733, 139410.

Future of Food: Journal on Food, Agriculture and Society
9 (2) May 2021

An investigation of the aspects affecting non-Muslim customers' purchase intention of halal food products in Jakarta, Indonesia

Anang Arifin[1], Ferdinand Wyman[1], Shintawati[1], Roozbeh Babolian Hendijani[1*]

[1]Binus Business School, Master Program, Bina Nusantara University, 10270 Jakarta, Indonesia

* Corresponding author: rhendijani@binus.edu

Data of the article

First received : 02 June 2020 | Last revision received : 25 February 2021
Accepted : 07 May 2021| Published online :25 May 2021
DOI : 10.17170/kobra-202102163257

Keywords

Halal food, halal logo, non-Muslim customers, purchase intention, quality

The international trade market of halal food products is vast and has become a fast-growing segment. Consumers must often consider whether their food and beverage choices are suitable for their health, well-being, nutrition, and physical fitness. Nowadays, halal products are requested by Muslim and non-Muslim customers due to safety and quality concern. Even though several studies have been conducted for Muslim customers, there is a lack of data from previous studies exploring non-Muslim customers about their intention to purchase halal food products in Indonesia. The aim of this study is to address the lack of data from previous research that explores the intention of non-Muslims customers to purchase halal food products in Indonesia by exploring the factors that affect the purchase intention and understand the correlation between the factors. In this study, halal awareness, halal logo, product quality, food safety, and halal perception were explored as factors affecting the purchase intention of halal food products by non-Muslim customers in Indonesia. The questionnaire was distributed using an online platform that targeted a minimum of 150 respondents with the specific criteria of non-Muslim, age 21-60 years old. The collected data was examined using the SPSS application, which is a multiple linear regression module. The analysis results indicate that only two variables have a significant effect on the intention to purchase halal food, namely the halal logo and product quality. Research can be a consideration for halal food producers and distributors to look at the opportunity to increase sales by targeting non-Muslim customers in Indonesia.

1. Introduction

Food and beverage consumers consider whether their product choices are suitable for their health, well-being, nutrition, and physical fitness (Skerrett & Willett, 2010). As for lifestyle, food and beverages play important roles in many sectors such as the spiritual life, cultural, and social existences of many people (Teng et al., 2013). Nowadays, halal products are requested by Muslim and non-Muslim customers due to safety and quality concerns (Alam & Sayuti, 2011).

Halal is the permitted behaviour or activities for Muslims, while haram refers to the behaviours and actions that are prohibited in Islam (Battour & Ismail, 2016). Based on SNI 99001:2016 (Standar Nasional Indonesia), halal products under this national standard include the raw materials derived from animals, plants, microorganisms, or materials produced through physical, chemical, biological or genetic engineering processes (Prasetya, 2019). In general, halal food products follow specific criteria on animal slaughtering,

alcohol use, and food sourcing, and more in-depth standards on processes, safety, hygiene, and quality assurance are introduced. Both Muslim customers and non-Muslim customers regard halal accreditation as a standard for food security and cleanliness, guaranteed quality, and many other advantageous attributes (Teng et al., 2013). Halal food, in line with the Tayyib concept, refers to a process of clean and pure food as a primary objective where a detailed evaluation of food content regarding halal, non-toxicity, safety, and hygiene status is required (Alzeer et al., 2017). According to Rahman (2017), the word Tayyib is translated as "good", "pure", or "wholesome". As an outcome, halal food industries will deliver superior quality food products different from other industries that apply only ordinary standards (Ali & Talib, 2009).

In different non-Muslim countries, such as Canada and Spain, people's enthusiasm for halal food is high (Wilkins et al., 2019), as well as the United Kingdom (Ayyub, 2015), which has been one of the fastest-growing halal food industry in the world (Ben-berry, 2011). In part, people pay more attention to the food they eat because it is related to health, hygiene, animal welfare, and food quality (Latif et al., 2014; Mathew et al., 2014).

The international trade market of halal food products is massive and considered the fastest-growing segment (Alam & Sayuti, 2011). The Pew Research Centre (2019) estimates that the Muslim population is approximately 1.9 billion worldwide, and this population places Muslims as the second-largest religious population after Christianity. Statistics show that the global market value of halal food worldwide was approximately 1.4 trillion US dollars in 2017 and is estimated to grow an estimated 2.6 trillion US dollars by 2023 (Shahbandeh, 2018). Halal food manufacturers and distributors could explore this as an opportunity to examine the influencing factors that lead to the purchase of halal food products by non-Muslim customers.

Indonesia is a nation with the largest Muslim population in the world (Masci, 2017). According to Badan Pusat Statistik Indonesia (BPS), in 2019, Indonesia's population was 267 million people, with 34.26 million non-Muslims (Databoks, 2019). Badan Pusat Statistik (BPS) said that in 2016, Indonesian people spent about 50% of their monthly incomes on food, spent mostly on processed food and beverages. The non-Muslim population in Indonesia is a highly prospective opportunity for the halal food business. Further investigation is compulsory to fully understand the purchase intention of halal food products by non-Muslim customers.

Many food industries in both Muslim and non-Muslim nations have adopted the halal concept. Data from the State of the Global Islamic Economy Report in 2018/19 by Latif (2018) quoted that Indonesia's halal market industry is always in the top eight rankings for each halal industry category. More so, Indonesia is in the first position for the halal food category with a spending value of 170 billion US dollars, compared to 43 billion US dollars from Turkey in the second position. Although Indonesia's halal industry market is one of the biggest in the world, this number is not in line with its production. Indonesia places 10th with a Global Islamic Economy (GIE) score of 45 (Latif, 2018).

Research on halal food for non-Muslims is scarce despite its revenue contributions (Wilkins et al., 2019). There has been a recognition that halal food represents cleanliness and adheres to safety procedures in producing high-quality products (Ambali & Bakar, 2014). Research should be held across the countries to understand customer behaviour towards halal food, including perception from non-Muslim customers about halal products (Wibowo & Ahmad, 2016). Some studies have been done to connect the intention to purchase halal food products among non-Muslim customers in Pakistan (Awan et al., 2015), the United Kingdom (Ayyub, 2015) and Malaysia (Abdul Latiff et al., 2013; Aziz & Chok, 2013; Teng et al., 2013; Rezai et al., 2012; Golnaz et al., 2010). However, research is limited in Indonesia, limiting complete understanding of non-Muslim customer intention in the largest halal industry market. This study examines the factors that affect the intention of non-Muslim customers to purchase halal food products in Indonesia, and its results can help address the lack of data (Rachbini, 2018; Notodisurjo, 2019; Jusmaliani, 2009) from previous research. With this information, halal food marketers and manufacturers could benefit from understanding how to establish the right approach and generate more sales by increasing their marketing and market shares.

2. Literature Review

Halal has become another way to claim trademarks in modern times (Wilson & Liu, 2010). The high enthusiasm for halal food products has risen in different non-Muslim nations such as Canada and Spain (Wilkins et al., 2019), as well as the United Kingdom (Ayyub, 2015), which has become the world's quickest developing halal food industry (Ben-berry, 2011) for two reasons. Firstly, halal food is considered cleaner, more healthful, and more delicious (Alam & Sayuti, 2011); secondly, it has gained significant acknowledgement worldwide through social digestion. Alam and Sayuti (2011) found that halal is acknowledged as a standard for affirming product quality and product safety.

2.1 Halal Awareness

Awareness is the capability to recognise certain affairs (Aziz & Chok, 2013). Muslims consume halal food products as acts of religious obligation. The halal principles should be manifested into meaningful impacts on customers' knowledge of halal standards (Rezai et al., 2012). Consequently, the intention to purchase halal food products has influenced customer awareness of halal items (Aziz & Chok, 2013). Research to understand the connection between halal awareness and halal products with purchase intention among non-Muslim customers has been conducted (Boo et al., 2015). It was found that non-Muslim customers look for food safety when purchasing halal food products. Customers will likely purchase halal food products if they have an awareness of the products and good perceptions of the products. This suggestion reflects that non-Muslim customers might be interested in halal food products if the value of consuming them is acknowledged. Therefore, this study put forth the following hypothesis:

H1: Halal awareness has a positive and significant effect on the intention to purchase halal food products.

2.2 Halal Logo

A logo is an image design that communicates to customers and is free of verbal data (Lans et al., 2009). A logo is important to distinguish certain product aspects and bridge them to the public (Ad et al., 2012). A halal logo can be found on the packaging of food products; it is a sign of approval from a registered accreditation body in a related country. A product that has a halal logo means that the product complies with certain conditions for consumption and helps customers make purchase decisions (Muhamad & Isa, 2017). It is also an assurance that the entire production process has complied with halal requirements (Lestari et al., 2018). The halal logo is an official certification that a product complies with a safe and hygienic food handling process from preparation, slaughtering, manufacturing, and storing (Lada et al., 2009). According to Sukandar (2019), the regulating provisions of halal products mention Tayyib as one of the product criteria, which is defined as good and safe to be consumed (food safety), hygienic, healthy, and good quality. Every country that produces halal products needs to issue halal logos managed by an established body such as Majelis Ulama Indonesia (MUI) in Indonesia. The government of Indonesia, through Badan Penyelenggara Jaminan Produk Halal (BPJPH), is now carrying out new halal certifications, with the food sector as a priority, after taking over from Majelis Ulama Indonesia (MUI) (Neo, 2019). Non-Muslim customers also look for the halal logo to identify halal food products (Aziz & Chok, 2013). Non-Muslim customers' behaviour in consuming halal food products is affected by their concern over food safety (Golnaz et al., 2010). According to the Theory of Planned Behaviour (TPB) (Ajzen, 1991), a positive personal attitude determines the perception of halal food products by non-Muslims (Golnaz et al., 2010), which influences their halal food purchase intention. With these factors involved, this study postulates the following hypothesis:

H2: A halal logo has a positive and significant effect on the intention to purchase halal food products.

2.3 Product Quality

The quality of a product is desirable for every customer. To compete in a dynamic market, especially in the food industry, one of the key parameters to consider is product quality (Du & Sun, 2006). Customers demand quality as a desirable characteristic of products or services (Canavari et al., 2010). Having an understanding of the connection between customer intention and food quality is important. According to a previous study (Ya, 2017), non-Muslim customers' perceptions of product quality significantly affect purchase intention for halal food products. In this case, non-Muslims see halal from its meaning and the value of the halal products. A previous study by Aziz and

ISSN-Internet 2197-411x OLCL 862804632
UniKassel & VDW, Germany-May 2021

Chok (2013) also discovered that non-Muslims consider halal food as hygienic and safe, and it follows the ethical treatment of animals in slaughterhouses. In other ways, perceived quality embodies a customer's understanding of general brands as top-ranking and aiming to perfection. According to Das (2014), excellence in offering a product or service will depend on the customer's acceptance of the quality that leads to recurring orders. Customers also become very careful when choosing their food for consumption after a health crisis outbreak like Mad Cow disease or avian influenza, and others (Ayyub, 2015). A further investigation needs to explore the behaviour in purchasing food products based on quality. Food quality is an important role in the termination of customer purchases. So, if the quality of food is improved, then the purchasing intention will also increase (Margareta & Edwin, 2012). This study proposes the following hypothesis:

H3: Product quality has a positive and significant effect on the intention to purchase halal food products.

2.4 Food Safety

Food safety refers to the treatment, preparation, and storage of food, implementing the best available methods to minimise the risk of contracting a foodborne illness. Thus, it is important for customers to be knowledgeable about the product ingredients, as it affects the purchase decision process (Ismail et al., 2018). According to Schmidt and Rodrick (2003), educated customers define food safety with nutritious food and cleanliness in mind. Religion positions are an important standard in the industry of food products (Al-Mazeedi et al., 2013).

Past studies have indicated that non-Muslim customers are interested in consuming and purchasing halal food items because they have the advantages of being cleaner, healthier, and of better quality (Aziz & Chok, 2013; Rezai et al., 2012). Problems about food safety, such as food without eligible certification, unclear ingredients, and documentation that does not match reality, are always there, and customers are always aware of it (Ambali & Bakar, 2014). Free trade today currently is geared towards an increase in varieties of food products on the market. Nowadays, the movements in worldwide food production, distribution, processing, and arrangement processes consistently pose new food security challenges (Thomas et al., 2015). The halal concept underscores cleanliness, safety, hygiene, virtue, and purity (Hussein et al., 2016). Food safety measures are mandatory for the food industry, bearing in mind that food safety can impact customers' health and well-being. Safety, quality, and signs related to food are motivations for the customers to make purchase decisions (Herath & Henson, 2006). This study postulates the following hypothesis:

H4: Food safety has a positive and significant effect on the intention to purchase halal food products.

2.5 Halal Perception

For non-Muslim customers, food perception is mainly influenced by cultural background and taste perceptions, known health effects, social influence, and knowledge about the related products (Mohd-Any et al., 2014). The information about the products can easily be seen on labels that include product ingredients, the manufacturer's name, origin, and verification of the product. Perception is indicated as a reason for customers' purchasing behaviour and loyalty to a group of products (Biswas et al., 2011; Wells et al., 2011; Wilson & Liu, 2010).

As a factor that is important to improve sales and increase the market share, customer perception of specific products needs to be explored. However, some limited studies have specifically analysed the relationship between product perception and purchase consideration and decisions (Biswas et al., 2011; Wells et al., 2011). One study explored factors including perceptions from non-Muslim customers about halal food products in the market. Customers have specific perceptions of the quality of products depending on the country of origin, including where it is designed, assembled, and produced (Biswas et al., 2011). Features of the products will affect the customers' perceptions of a particular product's advantages (Bertini et al., 2009). In addition, they found that the product's physical characteristics influence customer perception about a product's benefits. According to Ahmad et al. (2013), the misappropriation of certification by several irresponsible people has caused less trust in halal certification in the community. This research proposes the following hypothesis:

H5: Halal perception has a positive and significant effect on the intention to purchase halal food products.

2.6 Purchase Intention

Lin and Lu (2010) found that purchase intention is related to the motivation of customers to purchase a product that is created by their appraisal or viewpoints of a certain product. Their research also found that customers must go through several processes before finally deciding to purchase. According to Wang and Tsai (2014), purchase intention is triggered by a product's perceived benefits and values, and customers need awareness and information before deciding to purchase a product. Intention is interpreted as a personal capability that creates a behaviour and acts as an initiator for that behaviour (Ajzen & Madden, 1986). Experiential evidence has to substantiate that religious responsibility will affect the personal manner and behavioural intention, as well as guide judgment in choosing products to purchase (Elbeck & Mandernach, 2008). By measuring customers' purchasing intentions, the industry can understand how willingly a customer makes a purchase and increases the usage of a product (Irshad, 2012). Thus, to obtain prime results, the industry can plan marketing accordingly. The use of the theoretical framework proposed for this study is shown in Figure 1 below.

3. Methodology

Data was collected to better understand the purchase intention of non-Muslim customers for halal food products in Jakarta, Indonesia. This research followed a deductive approach using a questionnaire that consisted of 7 segments, including socio-demographic questions. Each segment consisted of 2 to 5 statements with a total of 26 statements. The statements of each segment were based on similar studies to understand purchase intention, halal perception, product quality, halal logo, halal awareness and food safety (Aziz & Chok, 2013; Amat et al., 2014; Aditami & Soepatini, 2016; Akbiyik & Eroglu, 2016; Muhamad & Isa, 2017; Pham et al., 2018). Sections 1 to 5 aimed to gain a better comprehension of non-Muslims customers' knowledge of halal food products considering a halal

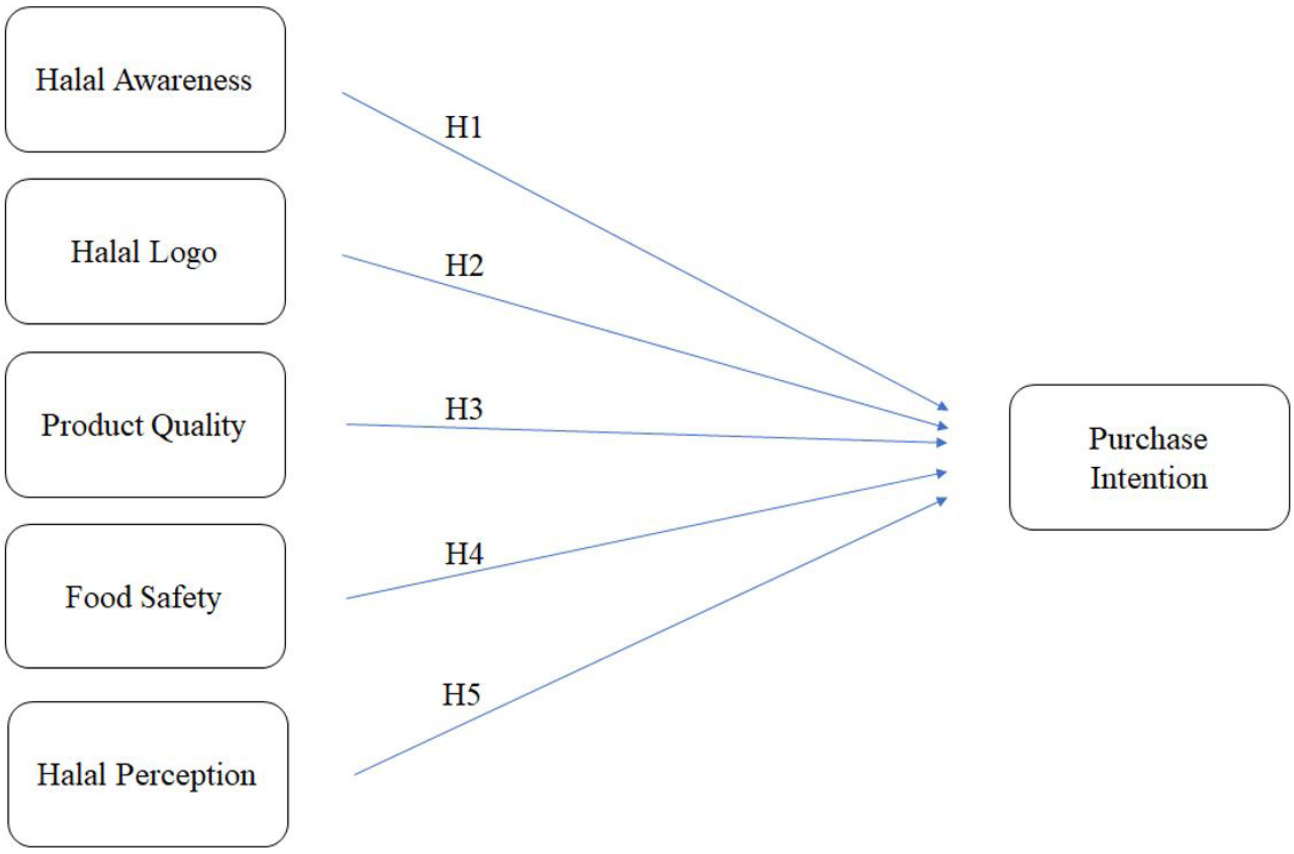


Figure 1. Theoretical framework

ISSN-Internet 2197-411x OLCL 862804632

logo, halal awareness, food safety, product quality, and halal perception. Each section was measured using a five-point Likert-type scale consisting of the values strongly disagree to strongly agree. Then it continued with the socio-demographic profile of the respondents. An online questionnaire using Google Form was distributed by filtering questions that were added to the questionnaire to ensure that all the respondents were non-Muslim.

The data was collected from 151 respondents and was based on previous research by Roscoe (1975). It was mentioned that the number of respondents could be ten times the number of variables when using multivariate analysis. The sampling of the research used a convenience method as one of the non-probability sampling techniques. Data were collected in April 2020. The data were processed using SPSS with frequency and multiple regression linear method analyses.

The sample frame of the study was conducted in Jakarta to measure the reliability of each factor and confirm the significant relationship between the questions and factors. For the reliability test, this study utilized Cronbach's alpha (α) with a range of acceptable values starting from α=0.45 until the excellent value of α=0.94 (Taber, 2017). A generally accepted rule is that an α of 0.6-0.7 indicates an acceptable reliability level (Hulin et al., 2001). The results of the reliability test were consistent and confirmed the significance between the questions and factors such as halal awareness (α=0.850), halal logo (α=0.689), product quality (α=0.895), food safety (α=0.953), halal perception (α=0.628), and purchase intention (α=0.802). The ANOVA table indicates that the model as a whole (which includes both blocks of variables) is significant [F (45, 421) =94.78, ρ<.0005). The F value is 45.988, and the data is significant (Sig. 0.000).

4. Findings and Discussion

The respondent profiles were even between male and female respondents, consisting of female respondents (50.3 per cent) and male respondents (49.7 per cent). The age group majority ranged between 31 - 40 years old (44 per cent). Most of the respondents' highest education level was a Bachelor's Degree (72 per cent). The marital status was dominated by singles (50.7 per cent) and married couples (48.7 per cent). Most of the respondents were employees (70.7 per cent). In terms of income, the majority generate more than 12 million rupiahs per month (42 per cent), as seen in Table 1.

The results in Table 2 are from the multilinear regression analysis, which examined the coefficient of the linear equation from the five factors of purchase intention. The impact of those five factors on purchase intention was significant [F (5, 144) =45.988; ρ=0.000] and contributed around 61.5 per cent (R Square = 0.615) toward purchase intention. This analysis also indicated that a halal logo (β= 0.209, Sig.= 0.014) and product quality (β= 0.491, Sig.= 0.000) significantly affect the purchase intention. While the factors that do not significantly affect the purchase, intention are halal awareness (β= 0.159, Sig.= 0.097), food safety (β= -0.024, Sig.= 0.769), and halal perception (β= 0.007, Sig.= 0.902). In order of importance is the halal logo (Beta=0.209) followed by product quality (Beta=0.491). The other factors do not make a unique contribution.

This study aimed to address the lack of data (Rachbini, 2018; Notodisurjo, 2019; Jusmaliani, 2009) from previous research that examined the factors affecting the intention of non-Muslim customers to purchase halal food products in Indonesia. The aspects included halal awareness, halal logo, product quality, food safety, and halal perception towards a purchase intention.
The halal logo significantly affects the intention to purchase halal food products, which is parallel with a previous study that showed that non-Muslim customers look for a halal logo to identify halal food products (Aziz & Chok, 2013). A halal logo is a visible sign that customers are supposed to identify on the packaging. It gives authenticity, which means that the product is halal qualified (Golnaz et al., 2010). Customers who already know halal will pay attention to the halal logo when purchasing food products. It is suggested to place the halal logo in a proper position and size to make it noticeable..

Product quality is also a significant factor in this research. Non-Muslim customers believe halal food products to have good product quality. This perception makes the customers willing to purchase, so they continue to consume and purchase the product

Table 1. Profile of Respondents

Socio-demographic factors	No	%	Socio-demographic factors	No	%
Gender			Marital Status		
Male	75	49.7	Single	76	50.7
Female	76	50.3	Married	73	48.6
			Divorced / Widowed	1	0.7
Age group					
21 to 30	58	38.7	Occupation		
31 to 40	66	44.0	Employee	106	70.7
41 to 50	15	10.0	Self-employed	29	19.4
Above 50	11	7.3	Student	5	3.3
			Retired	8	5.3
Education			Housewife	2	1.3
High School	4	2.7			
Diploma	9	6	Monthly income		
Bachelor	108	72	Less than IDR 3.500.000	8	5.3
Master/Doctorate	28	18.6	IDR 3.500.001 to IDR 8.000.000	40	26.7
Other	1	0.7	IDR 8.000.001 to IDR 12.500.000	39	26
			More than IDR 12.500.000	63	42

Table 2. Multiple Linear Regression Analysis Results

Multi Linear Regression					
Dependent Variable	***Independent Variable***	***R-Square***	***Unstandardized*** (β)	***Standardized*** (β)	***Significance***
Purchase Intention	Halal awareness	0.615	0.165	0.159	0.097
	Halal logo		0.252	0.209	0.014
	Product quality		0.534	0.491	0.000
	Food safety		-0.025	-0.024	0.769
	Halal perception		0.014	0.007	0.902

(ρ) < 0.05

repeatedly. The finding is consistent with a previous study by Ayyub (2015), who suggested that one factor that will significantly affect the decision to purchase is the quality of food. Previous researchers also found that quality is the motivating factor for Muslim and non-Muslim customers when purchasing food products (Alam & Sayuti, 2011; Aziz & Chok, 2013). Non-Muslim customers understand the importance of quality in food products, but it does not mean that non-Muslim customers prioritize halal food products due to food quality. In this study, the halal awareness factor does not significantly impact the intention of

ISSN-Internet 2197-411x OLCL 862804632

purchasing halal food products by non-Muslim customers.

Non-Muslim customers acknowledge halal as being something related to Islamic standards. This finding is in line with a previous study that revealed that halal food products are defined as acts of religious obligation (Hassan et al., 2009). Halal awareness does not significantly impact non-Muslim customers' intention to purchase, as they are not aware of the term halal itself. This research found that it was consistent with a previous study that showed the intention to purchase halal products was not affected by the awareness of halal (Awan et al., 2015). By knowing the benefits of healthier food consumption from halal products, the marketing could utilise the factors to increase the intention to purchase halal food products, especially for non-Muslim customers.

Customers will think and feel about a company's product or service and then decide whether to purchase it or not, according to the definition of Ya (2017). This study reveals that the perception of halal does not affect the purchase intention of halal food products, which is contrary to the previous study. It means that non-Muslim customers in Indonesia relate halal as being an obligation for Muslims. Therefore, it is not viewed as essential for them to purchase. The perception can be changed when non-Muslim customers view halal food products in ways that highlight health and environmental benefits.

One of the halal product criteria is Tayyib, which is defined as good and safe to be consumed (food safety), hygienic, healthy, and of good quality (Sukandar, 2019), characteristics emphasised by the halal concept. Bergeaud-Blackler (2004) discovered that Muslims in France choose halal meat products due to spiritual responsibility, but the customers were convinced about the benefits behind it. However, the findings of this study indicate that food safety does not affect the intention of non-Muslim customers to purchase halal food products, which is aligned with a previous study from Lestari et al. (2018), who stated that perceived usefulness (healthy and safe) do not have a significant effect on intention. The previous study found that customers' intention can be developed if the customers have acquired a product for the quality of life and the underlying value before consuming halal food products (Lestari et al., 2018). The reason behind it is due to inadequate knowledge about halal products for non-Muslim customers in Indonesia. In addition, non-Muslim customers do not consider halal products to be safer than non-halal products.

5. Conclusion

This study aimed to address the lack of data (Rachbini, 2018; Notodisurjo, 2019; Jusmaliani, 2009) from the previous studies that examined the intention of non-Muslim customers to purchase halal food products in Indonesia. The study was examined to understand the factors affecting non-Muslim customers when purchasing halal food products. The research results suggest that non-Muslim customers' purchase intention towards halal food products is influenced by the halal logo and product quality, with the latter gaining a better, standardized coefficient beta. For non-Muslim customers, the way to distinguish a food item as halal is only through the halal logo on the package. The halal logo is a visible sign that is supposed to be seen clearly by customers on the packaging. It gives authenticity that the product is qualified. Customers who are already well acquainted with halal will look at the halal logo to decide their purchase. As for product quality, this factor is the most significant. Customers primarily look at product quality when purchasing food products. Customers believe product quality emphasises lifestyle and healthy behaviour. Other factors like halal awareness, food safety, and halal perception do not significantly affect the intention of purchasing halal food products for non-Muslim customers. The reason for the insignificant factor was that non-Muslim customers do not consider that halal food products are safer than non-halal food products. Moreover, non-Muslim customers are not aware of the halal itself to affect their perceptions about halal food products.

Halal food manufacturers should look at the opportunity to increase sales by targeting non-Muslim customers in Indonesia and focusing on the significant factors that affect purchase intention by non-Muslim customers. The relationship between purchase intention and halal awareness, halal logo, product quality, food safety, and halal perception were established (as shown in Table 2). The findings indicate a positive significance for H2 and H3. Therefore, these hypotheses

are supported. However, as shown in Table 5, halal awareness, food safety, and halal perception showed no significance with purchase intention. Therefore, H1, H4 and H5 are not supported.

5.1 Practical Implications

This study provides information on Indonesian food manufacturers and distributors by examining the influencing factors that lead to the purchase of halal food products. Concerning practical implications, food manufacturers may provide interesting facts and knowledge about the benefit of halal food products to rise the intention of purchasing halal food products among non-Muslim customers. Therefore, food marketers should take appropriate measures to promote their products, especially in quality areas, which is considered one of the most important factors that have a significant impact on purchase intention, as reported in this research.

The results show that having a strategy to explore the halal logo and product quality when creating their products may bring prosperity to increase the market share for halal food manufacturers and distributors. Food manufacturers need to produce their products with an adequate halal logo as a sign that customers will easily recognize. Obvious halal logos will give acknowledgement to customers in their process of making purchase decisions. Food ingredients written on the packaging of halal products can be utilised to compare products listed in the market by customers. Customers that are aware of halal products will pay attention to the halal logo and the product quality. Non-Muslim customers will gain awareness and a better understanding of the halal context, including health concerns through consumption. It is a marketer's job to promote the product and communicate the value of halal to the broader demographic segment of non-Muslim customers. As halal awareness increases, the intention to purchase halal products may also be affected.

5.2 Theoretical Implications

The research was conducted to address the data gap of previous research exploring non-Muslim customers and their purchase intention of halal food products, specifically in Indonesia. It was concluded that there was a change in the intention of non-Muslim customers to purchase halal food products in Indonesia. Non-Muslim customers do not relate halal food products with religion or Islamic products only but also notice the products' quality.

This research found that the factors that significantly affected non-Muslim customers in Indonesia regarding their intention to purchase halal food were the halal logo and product quality. Both factors can be used as a basis for conducting an investigation or a similar study. These factors can also be used as a reference for a variety of studies and topics investigating factors that affect the purchase intention of halal food products.

5.3 Limitations and Future Recommendations

This study was limited by factors that have been tested to understand the intentions of non-Muslim customers to purchase or consume halal food products. For future studies, it is important to consider other factors like brand, price, promotion, and food preparation process. This study was also limited because the respondents were limited to Jakarta. This study suggests that future studies should include other Indonesian metropolitan cities, such as Semarang, Surabaya, Makassar, and Medan, to increase the sample size and expand the localisation of studies. For future research, it would be interesting to conduct a study on a city with a majority of non-Muslims, like in Bali or Manado.

Since the study was conducted using a quantitative approach, there was insufficient in-depth data. Consequently, it is recommended that a qualitative approach be used in future research to get a deeper understanding of non-Muslim customers.

Conflict of interest

The authors declare no conflict of interest. Besides, the funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

References

Abdul Latiff, Z. A., Mohamed, Z. A., Rezai, G., &

ISSN-Internet 2197-411x OLCL 862804632
UniKassel & VDW, Germany-May 2021

Kamaruzzaman, N. H. (2013). The impact of food labeling on purchasing behavior among non-Muslim consumers in Klang Valley. Australian Journal of Basic and Applied Sciences, 7(1), 124-128.

Ad, G., Adr, V., & Pascu, N. E. (2012). Logo design and the corporate identity. Procedia-Social and Behavioral Sciences, 51, 650-654.

Aditami, S., & Soepatini, S. M. (2016). The analysis of halal product purchase intention using Theory of Planned Behavior (TPB): An application on bakery product consumption. Muhammadiyah University of Surakarta, Indonesia.

Ahmad, N. A., Abaidah, T. N., & Yahya, M. H. A. (2013). A study on halal food awareness among Muslim customers in Klang Valley. In The 4th International Conference on Business and Economic Research (4th icber 2013) Proceeding (Vol. 1074).

Ajzen, I. (1991). The theory of planned behavior. Organizational Behavior and Human Decision Processes, 50(2), 179–211. doi: 10.1016/0749-5978(91)90020-t

Ajzen, I., & Madden, T. J. (1986). Prediction of goal-directed behavior: Attitudes, intentions, and perceived behavioral control. Journal of Experimental Social Psychology, 22(5), 453–474. doi: 10.1016/0022-1031(86)90045-4

Akbiyik, F., & Eroğlu, H. (2016). A study to determine consumers' attitudes, expectations and perceptions for halal certified products: Isparta Province as an example. International Journal of Social Science Studies, 4(4), 56-68. doi: 10.11114/ijsss.v4i4.1382

Alam, S. S., & Sayuti, N. M. (2011). Applying the Theory of Planned Behavior (TPB) in halal food purchasing. International Journal of Commerce and Management, 21(1), 8-20. doi:10.1108/10569211111111676

Ali, K. A., & Talib, H. A. (2009). An overview of the Malaysian food industry: The opportunity and quality aspects. Pakistan Journal of Nutrition, 8(5), 507-517. doi:10.3923/pjn.2009.507.517

Al- Mazeedi, H. M., Regenstein, J. M., & Riaz, M. N. (2013). The issue of undeclared ingredients in halal and kosher food production: A focus on processing aids. Comprehensive Reviews in Food Science and Food Safety, 12(2), 228-233.

Alzeera, J., Riederb, U., & Hadeeda, K. A. (2017). Rational and practical aspects of halal and Tayyib in the context of food safety. Trends in Food Science & Technology, 71, 264-267. https://doi.org/10.1016/j.tifs.2017.10.020

Amat, M. B., Asshari, N. B., & Sundram, V. P. (2014). The influence of Muslim consumer's perception toward halal food product on attitude at retail stores. Social Science Research Network Electronic Journal, 23Journal, 23, 1-11. doi:10.2139/ssrn.2541203

Ambali, A. R., & Bakar, A. N. (2014). People's awareness of halal foods and products: Potential issues for policy makers. Procedia - Social and Behavioral Sciences, 121, 3-25. doi:10.1016/j.sbspro.2014.01.1104

Awan, H. M., Siddiquei, A. N., & Haider, Z. (2015). Factors affecting halal purchase intention – Evidence from Pakistan's halal food sector. Management Research Review, 38(6), 640–660. doi: 10.1108/mrr-01-2014-0022

Ayyub, R. M. (2015). Exploring perceptions of non-Muslims towards halal foods in the UK. British Food Journal, 117(9), 2328-2343. doi:10.1108/bfj-07-2014-0257

Aziz, Y. A., & Chok, N. V. (2013). The role of halal awareness, halal certification, and marketing components in determining halal purchase intention among non-Muslims in Malaysia: A structural equation modeling approach. Journal of International Food & Agribusiness Marketing, 25(1), 1–23. doi: 10.1080/08974438.2013.723997

Battour, M., & Ismail, M. N. (2016). Halal tourism: Concepts, practices, challenges and future. Tourism Management Perspectives, 19, 150-154.

Ben-berry (2011). Global halal food market., Agriculture and Agri-food Canada, Ottawa, ON. Retrieved from https:// www.ats.agr.gc.ca/inter/4352-eng.htm

Bergeaud-Blackler, F. (2004). Social definitions of halal quality: The case of Maghrebi Muslims in France., In M. Harvey, A. McMeekin & A. Warde (Eds.), The qualities of food: Alternative theories and empirical approaches (pp.94-107). Manchester: Manchester University Press.

Bertini, M., Ofek, E., & Ariely, D. (2009). The impact of add-on features on consumer product evaluations. Journal of Consumer Research, 36(1), 17-28. doi:10.1086/596717

Biswas, K., Chowdhury, M., & Kabir, H. (2011). Effects of price and country of origin on consumer product quality perceptions: An empirical study in Bangladesh. International Journal of Management,. 28(3), 659-674.

Boo, Y. K., Noh, J. W., Kim, Y. M., Kim, S. S., & Rha, Y. A. (2015). Perception of privacy and sensitivity of personal information among university students. Culinary Science and Hospitality Research, 21(5), 25-37.

Canavari, M., Castellini, A., & Spadoni, R. (2010). Challenges in marketing quality food products. Journal of International Food & Agribusiness Marketing, 22(3-4), 203-209. doi:10.1080/08974431003641141

Das, G. (2014). Linkages of retailer personality, perceived quality and purchase intention with retailer loyalty: A study of Indian non-food retailing. Journal of Retailing and Consumer Services, 21(3), 407-414. doi: 10.1016/j.jretconser.2013.11.001

Databoks., (2019). Berapa Jumlah Penduduk Muslim Indonesia? (n.d.). Retrieved from https://databoks.katadata.co.id/datapublish/2019/09/24/berapa-jumlah-penduduk- Muslim-Indonesia

Du, C. J., & Sun, D. W. (2006). Learning techniques used in computer vision for food quality evaluation: A review. Journal of Food Engineering, 72(1), 39–55. doi: 10.1016/j.jfoodeng.2004.11.017

Elbeck, M., & Mandernach, J. (2008). Expanding the value of scholarly, open access e-journals. Library & Information Science Research, 30(4), 237- 241.

Golnaz, R., Zainalabidin, M., Mad Nasir, S., & Eddie Chiew, F. C. (2010). Non-Muslims' awareness of halal principles and related food products in Malaysia. International Food Research Journal, 17, 667–674.

Hassan, S. H., Dann, S., Annuar, K., Kamal, M., & De Run, E. C. (2009). 14 influences of the halal certification mark in food product advertisements in Malaysia. The New Cultures of Food: Marketing Opportunities from Ethnic, Religious and Cultural Diversity, 243.

Herath, D., & Henson, S. (2006). "Does Canada need mandatory HACCP? Evidence from the Ontario food processing Sector". Canadian Journal of Agricultural Economics, 54(4), 443–459.

Hulin, C., Netemeyer, R., & Cudeck, R. (2001). Can a reliability coefficient be too high? Journal of Consumer Psychology, 55-58.

Hussain, I., Rahman, S. U., Zaheer, A., & Saleem, S. (2016). Integrating factors influencing consumers' halal product purchases: Application of the Theory of Reasoned Action. Journal of International Food & Agribusiness Marketing, 28(1), 35-58. doi:10.1080/08974438.2015.1006973

Irshad, W. (2012). Service based brand equity, measure of purchase intention, mediating role of brand performance. Academy of Contemporary Research Journal, 1(1), 1-10.

Ismail, I., Abdullah, N. A., Ahmad, Z., & Sidek, N. L. (2018). Halal principles and halal purchase intention among Muslim consumers. Proceedings of the 3rd International Halal Conference (INHAC 2016), 131-138. doi:10.1007/978-981-10-7257-4_12

Jusmaliani, & Nasution, H. (2009). Religiosity aspect in consumer behavior: Determinants of halal meat consumption. ASEAN Marketing Journal, 1,1-11. 10.21002/amj.v1i1.1977.

Lada, S., Tanakinjal, H. G., & Amin, H. (2009). Predicting intention to choose halal products using the Theory of Reasoned Action. International Journal Islamic and Middle Eastern Finance and Management, 2(1), 66–76

ISSN-Internet 2197-411x OLCL 862804632

Lans, R. V., Cote, J. A., Cole, C. A., Leong, S. M., Smidts, A., Henderson, P. W., & Schmitt, B. H. (2009). Cross-national logo evaluation analysis: An individual-level approach. Marketing Science, 28(5), 968-985. doi:10.1287/mksc.1080.0462

Latif, I. A., Mohamed, Z., Sharifuddin, J., Abdullah, A. M., & Ismail, M. M. (2014). A comparative analysis of global halal certification requirements. Journal of Food Products Marketing, 20, 85-101. doi:10.1080/10454446.2014.921869

Latif, H. (2018). State of the Global Islamic Economy Report 2018/19. Thomson Reuters. https://haladinar.io/hdn/doc/report2018.pdf

Lestari, Y., Susanto, J., Simatupang, T., & Yudoko, G. (2018). Intention towards halal logistics:A case study of Indonesian consumers. Journal for Global Business Advancement, 11(1), 22. doi: 10.1504/jgba.2018.093184

Margareta, F. S., & Edwin, J. (2012). Analisa pengaruh food quality dan brand image terhadap keputusan pembelian roti kecik toko roti Ganep's di kota Solo. Jurnal Manajemen Pemasaran, 1(1), 1-6.

Masci, D. (2017, January 31). World Muslim population more widespread than you might think. Retrieved May 10, 2020, from https://www.pewresearch.org/fact-tank/2017/01/31/worlds-muslim-population-more-widespread-than-you-might-think/

Mathew, V. N., Amir Abdullah, A. M., & Mohamad Ismail, S. N. (2014). Acceptance on halal food among non-Muslim consumers. Procedia - Social and Behavioural Sciences, 121, 262 – 271.

Mohd-Any, A. A., Mahdzan, N. S., & Cher, C. S. (2014). Food choice motives of different ethnics and the foodies segment in Kuala Lumpur. British Food Journal, 116(12), 1879 - 1896.

Muhamad, N., Leong, V. S., & Isa, N. M. (2017). Does the country of origin of a halal logo matter? The case of packaged food purchases. Review of International Business and Strategy, 27(4), 484-500. doi: 10.1108/ribs-06-2017-0049

Neo, P. (2019, October 28). 'New era' for halal in Indonesia: Understanding the country's new certification system. Foodnavigator-asia. Retrieved May 25, 2020, from https://www.foodnavigator-asia.com/Article/2019/10/28/New-era-for-halal-in-Indonesia-Understanding-the-country-s-new-certification-system

Notodisurjo, P., Syah, T., Anindita, R. (2019). The effect of religiosity moderation to halal logo on increasing muslim purchase intention in Jakarta. Russian Journal of Agricultural and Socio-Economic Sciences, 89(5), 140-147. doi:10.18551/rjoas.2019-05.17

Pham, T. H., Nguyen, T. N., Phan, T. T., & Nguyen, N. T. (2018). Evaluating the purchase behavior of organic food by young consumers in an emerging market economy. Journal of Strategic Marketing, 27(6), 540-556. doi: 10.1080/0965254x.2018.1447984

Prasetya, B. (2019, November 12). SNI 99001:2016 Sistem Manajemen Halal (Indonesia, Badan Standardisasi Nasional, Jakarta, Indonesia). Retrieved January 28, 2021, from https://isef.co.id/presentation/ISEF2019/ 12Nov2019/Global%20Halal%20Dialogue/04_ISEF_2019_Standardization%20and%20Accreditation%20in%20Halal%20Product.pdf

Rachbini, W. J. (2018). The relationship of attitude, subjective norm, perceived behavioral control on halal food purchasing behavior in Jakarta. Journal of Business and Management, 20(2), 01-10.

Rahman, S. A. (2017, February 17). Religion and Animal Welfare-An Islamic Perspective. Animals: an open access journal from MDPI. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5332932/.

Rezai, G., Mohamed, Z., & Shamsudin, M. N. (2012). Non-Muslim consumers' understanding of Halal principles in Malaysia, Journal of Islamic Marketing, 3(1), 35-46.

Roscoe, J. T. (1975). Fundamental research statistics for the behavioral sciences. New York: Holt, Rinehart and Winston.

Schmidt, R. H., & Rodrick, G. E. (2003). Food Safety Handbook. Hoboken: NJ: John Wiley & Sons, Inc.

Shahbandeh, M. (2018). Global market value of halal

food 2017-2023. Statista. Retrieved from https://www.statista.com/statistics/562857/market-value-of-halal-products-worldwide/

Skerrett, P. J., & Willett, W. C. (2010). Essentials of healthy eating: A guide. Journal of Midwifery & Women's Health, 55(6), 492-501. doi:10.1016/j.jmwh.2010.06.019

Sukandar, A. (n.d.). Ketentuan regulasi halal dalam penyelenggaraan JPH di Indonesia (Rep.). Retrieved January 25, 2021, from Badan Penyelenggara Jaminan Produk Halal website: http://www.halal.go.id/cms/assets/files/ Materi_Pak_Sukandar_compressed.pdf

Taber, K. S. (2017). The Use of Cronbach's Alpha when developing and reporting research instruments in science education. Research in Science Education, 48(6), 1273-1296. doi:10.1007/s11165-016-9602-2

Teng, P. K., Jusoh, W. J. W., Siong, H. K., & Mesbahi, M. M. (2013, June). Awareness, recognition, and intention: Insights from a non-Muslim consumer survey regarding halal labeled food products in Malaysia. In 3rd International Conference on Management Proceeding, Penang, Malaysia, 10-11 June 2013, pp. 10-11.

Thomas, A. M., White, G. R., Plant, E., & Zhou, P. (2015). Challenges and practices in Halal meat preparation: A case study investigation of a UK slaughterhouse. Total Quality Management & Business Excellence, 28(1-2), 12-31. doi:10.1080/14783363.2015.1044892

Wang, Y., & Tsai, C. (2014). The relationship between brand image and purchase Intention: Evidence from award winning mutual funds. The International Journal of Business and Finance Research, 8(2), 27-40.

Wells, J. D., Valacich. J. S., & Hess, T. J. (2011). What signal are you sending? How website quality influences perceptions of product quality and purchase intentions. MIS Quarterly, 35(2), 373-396. doi: 10.2307/23044048

Wibowo, M. W., & Ahmad, F. S. (2016). Non-Muslim consumers' halal food product acceptance model. Procedia Economics and Finance, 37, 276-283. doi:10.1016/s2212-5671(16)30125-3

Wilkins, S., Butt, M. M., Shams, F., & Pérez, A. (2019). The acceptance of halal food in non-Muslim countries. Journal of Islamic Marketing, 10(4), 1308–1331. doi: 10.1108/jima-11-2017-0132

Wilson, J. A. (2014). The halal phenomenon: An extension or a new paradigm? Social Business, 4(3), 255-271. doi:10.1362/204440814x14103454934294

Wilson, J. A., & Liu, J. (2010). Shaping the halal into a brand? Journal of Islamic Marketing, 1(2), 107-123. doi:10.1108/17590831011055851

Ya, S., Nor, M. M. N., Noor, S. M., & Ahmad, Z. (2017). Purchase intention of Islamic brand product among non-Muslim customers. Pertanika Journal of Social Sciences & Humanities, 25(S), 101-110.

Zakaria, N., & Abdul-Talib, A. N. (2010). Applying Islamic market-oriented cultural model to sensitize strategies towards global customers, competitors, and environment. Journal of Islamic Marketing, 1(1), 51–62. doi: 10.1108/17590831011026222

ISSN-Internet 2197-411x OLCL 862804632

Research Paper

Future of Food: Journal on Food, Agriculture and Society
9 (2) May 2021

Trust and the clean food imaginaries: an analysis of a short food supply chain from Romania

HESTIA I. DELIBAS[1*]

[1]Democracy in the XXI century - CES-FEUC doctoral programme, University of Coimbra, Coimbra, Portugal

* Corresponding author: hestiadelibas@ces.uc.pt

Data of the article

First received : 27 October 2020 | Last revision received : 23 February 2021
Accepted : 09 May 2021| Published online :25 May 2021
DOI : 10.17170/kobra-202102163258

Keywords

organic certificates, community-supported agriculture, trust, social embeddedness, Romania, Alternative food networks, organic food

As concerns about food safety and environmental issues gain more attention in the public eye, organic labels are growing in popularity, being presented as the solution for a more sustainable and conscious food system. Yet, organic certificates have not actively managed to change the food system but merely created a niche to be exploited. Through an Alternative Food Network framework, this paper looks at how small producers, who are otherwise excluded from accessing the premium prices of organic food markets, can still seize community economic rent through the close relationship formed as part of community-supported agriculture. Using a qualitative research methodology based on semi-structured interviews and secondary data analysis, and drawing from Alternative food networks literature, this paper investigates one alternative network from Romania called Peasant Box (Cutia Țăranului). Peasant Box re-spatialises the distribution chain by creating a direct selling network between food producers and consumers. This research focuses on how consumers and producers perceive the value of food and the distinct discursive constructions regarding food, as either valued based on the place of origin (authenticity) or on its production (naturalness). Peasant Box operates outside formalised certification, and the food is considered good by virtue of trust, which is formed through the long-lasting relationship between consumers and producers.

1. Introduction

The rising awareness about the harmful consequences of intensive agriculture for both the environment, through the loss in biodiversity, use of harmful chemicals in the soil, and for local communities, due to the loss of jobs to automation and the marginalisation of small producers, has resulted in an increased demand for products obtained through more responsible practices like ecologically grown and Fair-trade products. The quality turn (Goodman, 2003), as it is often called, is the premise for many of the alternative food movements seen today.

The rising demand for these types of products has led to the creation of third-party or voluntary organic certification schemes that require a series of standards that ensure the food obtained meets ethical concerns. In Romania, as in many other countries, the process of organic certification is made through private agents that have the role in inspecting and overviewing the producer, and ensuring the standards of production are implemented (Order nr. 895/2016). To become certified, the producers must subject themselves to a long and heavily bureaucratic procedure, as well as to random inspections and sampling. The process of transitioning from standard to certified organic agriculture is not affordable for everyone. Thus, it creates a

scarcity of certified products, which further increases the prices, offering an incentive to economic agents that want to harbour the organic food market's economic rents. Apart from the exclusionary effect that organic certificates can have, it is also worth mentioning the danger of encouraging the same behaviours they are supposed to deter when corporations adopt these organic standards without changing the productivist logic that underlies the entire industry. Moreover, by being voluntary, organic certifications do not change the system of food production and distribution to a more just and sustainable one, but merely create a niche in the market to be exploited. The system which produces cheap food with harmful methods remains the same, and functions, alongside the certified organic ones, creates consumption inequalities, by only offering the chance of safe and ethical consumption to those who can afford it.

Alternative food networks, especially direct selling networks like CSA (community-supported agriculture) are meant to address this issue by re-introducing social relations into the food system, fostering a logic of care and reciprocity as opposed to only a market-driven logic. That is not to say the CSA functions completely outside the market's logic, but there are indeed certain aspects of these practices that cannot be understood simply in utilitarian terms. More than that, the direct relationship between consumers and producers that stands as the premise of these kinds of networks is founded on trust and builds up trust. Consequently, farmers can pick the economic rents (Galt, 2013, p. 345) not based on third party certifications but based on the consumer trust fostered by direct relationship and on the moral value ascribed to the food (as being more sustainable or more just to the local communities).

This paper focuses on one of these types of alternative distribution networks from Romania, called Peasant Box (Cutia Țăranului), which works based on a direct subscription to a near-city farm, which periodically prepares and delivers a box of various seasonal foods obtained in the household. The subscription is a long-term one, excluded from the possibility of purchasing a box only once, precisely to encourage the formation of a relationship between consumer and producer. This study aims to uncover how food is understood and perceived by the producers and consumers at Peasant's Box, unravelling the discourse around food certificates and the "clean" food imaginary.

1.1 Alternative food networks – conceptualisation and critical reflections.

Alternative food network (AFN) is a broad term that incorporates several food production and distribution practices that present themselves as an alternative to conventional distribution systems (Corsi et al., 2018, p. 10). These practices can take various forms, among which we list community-supported agriculture (CSA), farmer's markets, direct distribution schemes, solidarity purchasing groups, urban gardens, agricultural cooperatives (Harris, 2010, p. 355). These practices are so varied, and "AFN" serves more as an umbrella term that is defined by its opposition to mainstream distribution channels (Renting, Schermer, & Rossi, 2012, p. 291).

Given that these alternative distribution chains cannot be directly defined, it is necessary to refer to some key features they have. First of all, they exist in a political context of the global economic restructuring, concerns about social justice and environmental sustainability as well as a decline of rurality and a de-localisation of the entire production process, driven by neoliberal changes (Moragues-Faus, 2017). Therefore, it is a large-scale movement in which consumers play an active role, politically assumed, based on ethical principles. AFNs are characterised by the relationship between consumer and producer that extends beyond an instrumental purpose so that participation in this type of exchange has an intrinsic symbolic value for both parties beyond market logic (Corsi et al., 2018, p. 201). The re-spatialisation of production and distribution and the establishment of a relationship based on solidarity, are the premises of these various types of exchanges (Harris, 2010, p. 355). It is important to point out that the localisation of food systems is not intrinsically more ethical or just. In the literature, localism is problematised as a form of normative discourse, which tends to naturalise an ideal about what it means to produce and consume food. Non-reflective localism transposes a standardised, apparently a-political vision of what quality means in food production, equating the place with the correct way of living and consuming. In their paper, DuPuis, & Goodman (2012 p.364) propose the term reflexive localism, as a solution to this type of discourse that universalises a certain elitist lifestyle, which involves taking a polit-

ISSN-Internet 2197-411x OLCL 862804632

ical position in opposition to globalism as a starting point for a movement focusing on local consumption. The study of short distribution chains raises the issue of defining these systems using the concept of "alternative", referring to the quality of these systems being distinctive to globalised distribution systems (Holloway et al., 2007, p. 2). The alternative-conventional duality can thus generate ambiguity; in reality, the economic practices that characterise these networks are not so easily placed in one of the two spheres. Due to the heterogeneity of consumers' motivations to participate in such schemes, classifying into one of the categories becomes difficult. The alternative-conventional dichotomy should thus be understood in the form of a continuum within which these practices can be placed (Corsi et al., 2018, p. 307).

Because AFN can have such a wide configuration of practices, it is important to consider the scale at which various AFN function and the kind of relations they generate. Thus, Renting et al. (2003) distinguish three categories of AFN based on the type of interaction created between consumer and producer. First, face-to-face AFNs have the component of a direct relationship based on trust between consumer and producer as the main premise. Examples of such AFNs are farmers market, box schemes, and pick your own. Secondly, there is proximate AFNs, in which the product is sold regionally, and the relation between producer and consumer is mediated by a third party that acts as a guarantor of the product quality or authenticity. Examples may include farm shops and regional hallmarks. Thirdly, the authors name the extended AFNs, as food beyond the regional place of origin, relying heavily on institutionalised certifications or labels as a guarantee for quality and particular practices in the production process (like organic or fair-trade practices). In this last category, the direct relation with the producer or the place of origin is not as important as the inscribed symbolic value translated by the label (Renting et al., 2003, p. 400).

Apart from classifying AFN based on the type of relations, it encompasses, Renting et al. (2003) propose two categories for quality definitions. As we will see in this analysis, the categories are particularly useful in understanding consumers and producers discourse revolving the value of food. The quality definitions are relevant to AFN because "the more embedded and differentiated a product becomes, the scarcer it becomes in the market." (Renting et al., 2003, p. 401) The first category emphasises the place of origin for the product or process of production, thus being local, artisanal or traditional is the main selling point. The second category refers to the bioprocess of production, incorporating ecological practices to respond to various environmental and safety concerns. This category also plays on the idealised understanding of traditional farming as more natural.

Alternative food networks are thought to be examples of moral economies (Thompson, 1971) based on the presumption of the logic of care and social embeddedness that transgress the purely utilitarian market interactions, by adding ethical considerations and feelings of solidarity (Psarikidou, 2012, p. 310). Hinrichs (2000) proposes the concepts of marketness and instrumentalism for evaluating the degree of social embeddedness of economic transactions (p. 297). Marketness refers to the extent to which price is the primary driver in economic interactions. Thus, when marketness is high, the only consideration in the decision-making process of the economic actors is the price. In contrast, when marketness is low, there are other considerations beyond price that influence actors' decisions (Hinrichs, 2000, p. 297). On the other hand, instrumentalism refers to the level that economic actors are motivated by the maximisation of their self-interest, as opposed to other non-economic goals. As Galt (2013) points out, social embeddedness should not be understood as an exclusion to any capitalist logic, thus creating a false dichotomy, but as a continuum that can characterise any market interaction, in one degree or another (p. 348).

1.2 Organic Certifications

The term "quality turn" (Goodman, 2003) is often put in relation to the proliferation of diverse alternative food networks. Increased public concerns over food safety and growing awareness about the destructive and harmful methods used in food production for both the environment and local communities have led to an increasing number of people seeking alternatives to conventional food production and demand more transparency.

The response to the increasing demand for food produced with ethical and ecological concerns was the creation of certified organic labels. This response

meant introducing an elaborate set of rules and standards overseen by third-party certification authorities that would allow the producer to access premium prices (Guthman, 2004, p. 514). Labelling often implies a considerable amount of paperwork, fees that cut into the farmers' margins, intrusive surveillance, periodical inspections and randomised sampling for testing in search or prohibited chemicals that might have been used. As Guthman (2004) points out, the cost of transitioning to organic agriculture has an exclusionary effect, keeping out those who cannot afford the costs. More than that, "what is fundamentally troubling about these proactive standards is that their efficacy turns on rents, the dynamics of which can undermine the behaviours that the standards are intended to produce" (p. 524). As result, organic labels have not managed to reform the global food system, resulting only in the commodification of social and environmental-friendly practices. If initially certificates were meant to offer more transparency to the consumer and build trust, they were slowly co-opted into corporate practice, which transformed them into another marketing tool.

Economic rents can be understood as surplus profits, or "over profits in the marketing of some products based on constructed scarcity" (Guthman, 2004, p. 512). The scarcity, in the case of organic certificated food, derives from the limited access of farmers to get certification due to the high costs and other logistical difficulties, but also because of the consumer-driven, high-value on certificated food, which is regarded as having properties that make it superior to conventionally produced food. In the case of Alternative food networks, especially those which produce a personal relationship between producers and consumers, like community-supported agriculture or Solidarity Purchase Groups, economic rents can be in the form of organic certifications, but could also emerge as a form of "community economic rent" understood as premium prices justified by the trust built through the direct relationship and the symbolic value attributed to food as being more local or grown through civic agriculture (Galt, 2013, p. 345).

This paper contributes to the literature on AFN by uncovering the narrative constructions people build around the food produced through un-conventional chains of food production, adding a more nuanced understanding of consumer's motivation for partaking in relations based on trust and social embeddedness.

2. Materials and Methods

This research aims to analyse an alternative distribution network in Romania to understand what factors determine both consumers and producers to participate in this type of alternative distribution chain as well as the nature of the relationship between producer and consumer and the discursive constructions regarding food. The research aims to answer one main research question: How is "alternative agriculture" understood by producers and consumers of a short food supply chain from Cluj-Napoca? Two additional sub-questions were posed to narrow the scope of the study:

a. How is the value of food constructed and on what grounds?
b. What drives consumers to assume these perspectives regarding the food they receive through this AFN?

A qualitative research method based on the technique of interview and secondary data analysis was carried out to answer these questions. A case study research strategy was used, and the subject of the case study is represented by a short distribution chain, called the Peasant's Box. Peasant's Box was established in 2012, and it operates in 10 counties of Romania with around 25 producers and a few hundred consumers. This network works by directly subscribing a consumer to a farm near the city, which prepares and delivers a weekly box of various seasonal foods obtained from the household.

This research is based on data analysis obtained through 14 interviews conducted over six months (December 2019 to May 2020). The interviews were held with producers, consumers and the project initiator: 6 producers from the counties of Cluj, Sibiu, and Timisoara, from which one was a former producer at Peasant Box, 6 consumers from Peasant Box, from Cluj and Constanta, from which 2 were former consumers and the rest active consumers, 1 consumer and also an activist for peasant rights from ASAT (The Association for supporting peasant agriculture), and

ISSN-Internet 2197-411x OLCL 862804632

Table 1. Interviews classified by current or former involvement in the AFN

	Consumer	Producer	Initiator	ASAT
Current	4	5	1	1
Former	2	1		

1 of the initiators from Peasant Box. The ASAT consumer offered great insights on how other such community-supported agriculture (CSA) projects are governed, enabling comparisons between the two. From the 14 interviews taken, 11 were with women and 3 with men. In the interviews' citation, the distinction is made by marking F for the women and M for the men. Obtaining the interviews was done in two ways: some of the respondents were introduced through the project initiator by request, while others were selected through snowball sampling method. The interviews were recorded and transcribed, and most of them were done via phone or internet, as the COVID-19 lockdown was in place during the fieldwork.

The interviews were semi-structured, conducted based on an interview guide, specifically design for each actor interviewed: producer, consumer and initiator. The interview guide consists of five sections. (1) Introductory questions for the background of the interviewee, details about the farm, in the case of producers, and details on how they came to participate in this distribution chain; (2) Description of the exchange process and how the network functions in practice; (3) Details on the lived experience as part of the network; (4) Sections focused on the motivations for participation in this short food supply chain; (5) What are their relationship with consumer/producer. Secondary data was represented by pieces of information found on the online site dedicated to the project (https://cutiataranului.ro/), more precisely blog pieces, in which the political perspective of the initiators, as well as their vision for what the network should or could be, the list of rules for becoming a member/producer and the presentation of each producer and the box they offer.

3. Results

This chapter introduces the Peasant Box initiative, presenting the context of its inception, how it functions in practice and what rules and principles guide this type of alternative food network. Peasant Box (Cutia Țăranului) is a direct selling scheme between producers and consumers, which operates based on direct consumer subscription to a farm near the city that prepares and weekly delivers a box of various seasonal foods obtained in the household. The subscription is a long-term one, excluding the possibility of purchasing a box only once, precisely to encourage a direct relationship between consumer and producer. Also, the box value is not set strictly according to the market. Its content is diverse and reflects the production stages according to each season and the local varieties of vegetables or other products.

The community-supported agriculture (CSA) model is an alternative to the conventional food system, which connects the producer to the consumers, minimising the distribution chain, and consolidating long-lasting relationships between the two parties. It usually involves sharing the costs and risks of production by payment made at the beginning of the season and voluntary work done by consumers (Bîrhală & Möllers, 2014, p. 13). Peasant Box is presented by its initiators as a CSA project, although it differs from other such schemes in several ways. Peasant Box producers create diverse boxes (8-9 different products for the vegetable boxes, for example) that are also seasonal (with products grown in that season). The boxes are delivered periodically, having a fixed price but varied contents. The payment is made for each delivery, so in this regard, Peasant Box differs from other CSA schemes where the payment is made at the beginning of each season to offer the farmer the necessary capital to start the preparations, like buying seeds or necessary tools. Another particularity is that the delivery is made door-to-door by the producers on set days. Consumers are not involved in production or delivery, their role being minimal.

Peasant Box started in Cluj-Napoca in 2012, and to this day it has the largest number of producers from this area. However, in recent years it has also started to operate in other parts of the country (Timisoara, Iasi, Bucuresti, Sibiu). Its inception in Cluj-Napoca can be put in relation to several factors. First of all, Cluj-Napoca is one of Romania's largest cities, with a strong economic growth that has made it a regional centre for industry and services in recent years. (Petrovici, 2013). The city development has attracted both capital and specialised workforce resulting in a growing middle-class population, which has both the resources and interest in quality food. Another factor contributing to the success of Peasant Box in Cluj-Napoca, is the existence of a historical population specialising in urban vegetable growing, more exactly the hostezeni population, which have supplied the city with fresh products for generations. Hostezeni were urban dwellers who grew vegetables at the city's periphery, selling it in the local farmer's markets. They are thought to originate in the XVI century and provided food for the city until the 1980s when many were expropriated as the city expanded and their land was needed for new apartment buildings (Deac, Irimuș, & PĂCURAR, 2013). Very few hostezeni still practice agriculture today, and some are part of the Peasant Box network.

"We are proud to be able to continue the tradition of hostezeni inherited from our parents and to keep alive the memory of this tradition. Hostezeni are legendary farmers of Cluj - they always had fresh and quality goods (vegetables, wine, milk and of course sauerkraut according to a traditional recipe), they knew how to take care of their land and were respected over time." (Producer, online presentation).

Lastly, the Peasant Box project must be put in relation with the activist organisation for peasant rights Eco Ruralis of which the initiators, as well as some producers, are part. Eco Ruralis, which has its headquarters in Cluj-Napoca, is the largest organisation that fights for food sovereignty and peasant rights in Romania, engaging with advocacy work on issues such as land grabbing, agricultural subventions and traditional seed preservation. Apart from being the space where the platform was first initiated, the organisation also offers great support by promoting their initiative.

The online site makes some explicit requirements to be met to become a producer for Peasant Box. The first requirement is to have a good relationship with the earth. This formulation suggests that the project has the issue of agroecology in sight, and it does promote an alternative model of agriculture that is not based on intensive, industrialised methods, but rather on more traditional, or ecological practices. Still, the formulation is interpretable, leaving much room for projecting personal ideas to define a good relationship with the earth. In fact, Peasant Box does not impose one vision on what a good relationship might be, so the rule does not refer so much to a strict set of parameters that can be evaluated, but more to a set of principles or values that the peasant should adopt. The formulation remains vague and leaves each peasant to make up their own understanding of what it can mean for them.

By not imposing a strict standard, the initiators maintain a horizontal relationship with the farmers, allowing them the space to self-define the kind of agriculture they practice. It also brings awareness to the limitations of formalised organic certifications, that work as a form of gatekeeping due to the high cost and over-complicated paperwork. Thus, instead of having a state or private authority decides on the type of agriculture they practice and on the perceived quality of their goods, the platform leaves the definition to be constructed through negotiation by consumers and producers. More than that, this approach pushes for consolidation of a direct relationship between consumers and producers, who are bound to communicate. The producers have to be transparent, and the consumer gets involved in gaining knowledge about the production process. This act increases their awareness about an invisible process embedded in the food they are eating, which further increases the consideration for the producer. The food received is not just a product anymore; it is the result of a year-long process of nurturing and care, a process which is now exposed for the consumer to acknowledge. Suppose in the conventional food system, the supermarket's food has "no story to tell", in the sense that its origin and the stages of manufacture are invisible to the consumer. In that case, the food from this network contains the story of production.

The producers at Peasant's Box fall roughly under two categories. First, some producers have been farmers

ISSN-Internet 2197-411x OLCL 862804632

for most of their lives who continue to work on their family's land. This category of "traditional peasants" sell their food at the farmer's market and have a larger area of land producing for Peasant's Box, but also the market. Having been practising agriculture for a long time, the producers in this category had the necessary knowledge and did not need any assistance from the initiators. They also seem more concerned with making ends meet, discussing more practical issues of delivery and production. Moreover, producers from this category discussed, to a lesser extent, issues regarding agroecology or environmental concerns, framing the discussion about food more in terms of being obtained from traditional or small-scale agriculture.

The second category of producers is represented by people originally from urban areas, from middle-class positions, who have migrated to villages and started producing food. Producers from this category usually have a much more romanticised discourse about living in the country. They talk more about having a life away from stress, a much healthier and more natural lifestyle than their previous lifestyle.

"We really like this way of life, and this freedom to be in nature, to breathe fresh air and not be stressed. We've lived in these office jobs for years, where you go to work, then you come home and then you start all over again the next day. And then I realised, we don't want it anymore, we want to be free to make our lives the way we desire, and on top of that we also gain health from it." (Producer, F).

They are also more likely to be concerned about the food quality and aspects of biodiversity and ecological issues, which is reflected by their use of permaculture principles. Although many were novice agricultures who had to learn how to care for their plants and animals or plan their seeding and harvesting, producers from this category tended to look down on peasants lacking agroecological knowledge. They regarded peasants from their village as not cultivated enough on matters of ecological food production, the dangers of insecticides or how to grow novel varieties of plants. This differentiation between traditional and ecological practices shows a multiplicity of discourses and understanding of alternative agriculture. The project does not impose only one vision, offering space for a multiplicity of practices that can fall under the "alternative" umbrella.

Consumers expressed a very positive outlook on the project and the idea behind it, appearing to be satisfied with both the food received and the interactions with the producers. Consumers' motivations for participating in the network revolve around health and food safety concerns on the one hand, but also concerns about the fairness of the food system and an interest in supporting their community through their consumption choices. As one consumer said, "We were interested in two things, first to be not necessarily organic, but as healthy as possible and secondly to support these small, local producers" (Consumer, F).

Climate concerns were rarely mentioned as a motivation factor, and when mentioned, it was implicit only in the belief that it is important to have shorter distribution chains. "I wanted to stop buying vegetables from the supermarket to shorten the transport chain because at the supermarket products come from all over the world"(Consumer, F). The first primary motivation, related to health, was discussed more by consumers with children. The concern for food safety emerged when they became parents and became self-conscious about the origin of food and the dangers that mass-produced food might pose.

The ethical motivation of eating more locally, to protect the livelihoods of marginalised, small food producers, was addressed to a smaller extent by the consumers interviewed, but it was still an important motivation. The consumers referred to the unfairness in the food system and how big food retailers were profiting while at the same time offering low-quality food.

"I prefer to support and help someone local and who is personally involved in the production than the big retailers because you don't know where their product comes from, you don't know where it's going. That's why we don't support these very big retailers and we don't supply ourselves from the supermarket." (Consumer, F).

4. Discussion

4.1 Discourse about clean food

Food is never just food; it is a central part of daily life; it is at the centre of many human institutions and practices, and the focus of many political battles. When assessing the qualities of food, people incorporate their conceptual constructions in addition to physical properties, also symbolic or moral components. Before presenting the discursive constructions of Peasant Box consumers and producers regarding food, it is necessary to define the qualities of good food.

Food is considered "good" by virtue of possessing certain physical characteristics that set it apart from the food present in the conventional distribution chain. The most indicative quality invoked by all consumers when discussing food quality is taste, regarded as superior, more authentic, and caring great resemblance to the foods they had in their childhood (Watts, Ilbery, & Maye, 2005, p. 29).

They are made in the countryside, and I think they are made as our grandparents did. The food has a different taste, and I think they do not add any chemicals, or they don't spray the vegetables very much, as they produce food in small quantities. (Consumer, F) The produce's good taste is contrasted with the lack of taste of store-bought food. Visual qualities complemented the sensory experience of taste. Aesthetical aspects also contributed to the belief that the food was better than the mass-produced counterparts - the tomatoes were not perfect, the carrots had mud on them. The unattractiveness of the vegetables was a sign of authentically grown food on the earth. Being "ugly" was considered a positive quality that marks the product's authenticity; it is an image constructed in antithesis, again, with the supermarket products that have appealing aesthetic qualities but lack good taste.

"How can I tell you, you can see that the products are not standard, they still have stains and they spoil very quickly, from one week to the next, and what I bought from the store a month ago is still there, unspoiled. It has good taste. It is clear that they are homemade. "(Consumer, F).

Apart from the physical qualities, "good food" incorporates a series of moral or symbolic qualities related to its production. Thus, the food is thought to encapsulate values of respect towards the earth and biodiversity, being obtained through agro-ecological practices.

"We like it because it is fresh, relatively seasonal products from authentic local producers. We kind of know the conditions in which they make them. But they also have a different taste, you really feel that there is something really grown in the garden without a lot of herbicides and substances added." (Consumer, F).

The food is also thought to enclose the value of the hard work put in by the peasant. The close relationships formed between the peasant and the family they provide also offer the food a symbolic value that goes beyond the strictly physical quality.

"You know that someone invested his attention, his effort, a part of his soul and his experience is there. It's not something someone did on the conveyor belt, that's how I feel. The producer puts something there, and I feel that I receive more than just the product." (Consumer, F).

The food grown by the peasants at Peasant Box is mostly not certified organic; nevertheless, consumers do not perceive the food they receive to be similar to store-bought food. The term "clean food" is particularly used in place of organic or bio, which would only be possible based on a certification. Clean food can mean different things, as some people emphasise non-invasive agriculture practices, while others highlighted production by small semi-subsistence farmers. The lack of a clear definition leaves every actor to build their own constructive narrative around the food and the value it represents. It also leaves room for adopting practices that are not placed under strict parameters, which accounts for the possibilities of every producer to best manage their production. For example, some producers implement principles of permaculture in their production, while others rely on traditional methods. Some producers have micro-productions that offer them the possibility of tending the garden manually, while others use technology to work their field. Lastly, it also accounts for the moral economy in which Peasant Box functions, that cannot be regulated or standardised without losing its meaning and purpose.

The two discursive constructions built around food,

ISSN-Internet 2197-411x OLCL 862804632

using the Renting et al. (2003) classification of food quality definitions, are based on place of origin or the bioprocess of production. The first identified discourse is about authentic food from the country. Consumers and producers value the food on the merit of being grown in the village by the peasants, constituting an idealised rural life image. In this discursive form, a romanticisation of the rural space develops, which is seen to be intrinsically pure, good, and valuable. Thus, the image of the Romanian village becomes a mythical construction that incorporates moral meanings about a desirable way of life.

Being grown by peasants gives food from the Peasant Box an intrinsic value, making it more beneficial in the eye of the consumer. It is considered that the food from the peasants is produced through traditional methods, which offer food qualities beyond the physical ones, such as the capacity to preserve a rural way of life. It should be noted that these traditional methods are not clearly explained. Hence, they remain an ideal construction of the correct production and consumption of food rather than clearly stated practices. The authenticity of the products becomes an important aspect when choosing what to buy. Consumers worry about such authenticity when going to the peasant market, fearing not being able to tell which food comes from the peasants and which does not and hence not knowing which food possesses the symbolic value of being from the country or grown by small farmers. As a result, Peasant Box is preferred for giving the consumer the certainty about the place of origin.

"Well, in a way it's easier to go to the market, and when I go, I'm careful to take from local producers, but you don't always know where the respective products are from (…) it's more reliable to buy through Peasant Box and you don't have to ask questions about what you buy, from whom you took it, how it was transported." (Consumer, F).

This type of discourse idealises the countryside, essentialising certain features considered inherent to what country life means, such as subsistence living, the relationship with the land, and traditional knowledge. It is interesting to see that "peasant" or "rural", which can have negative societal connotations, is seen positively, denoting purity and authenticity. Adding to this discourse about authentic taste is the idea of food that tastes like childhood, mobilising subjective understandings and feelings of nostalgia.

"I grew up with these products, and they are very dear to me, I remember how my grandmother made them. My husband didn't grow up in the country at all and he doesn't know these products, but he also says that they are tastier." (Consumer, F).

The second discourse around food is constructed on the quality of being natural. Many consumers and producers regard the food from Peasant Box as better on the ground of being produced with non-invasive methods by not using pesticides or insecticides or using natural fertilisers, not artificial ones. "They are not spectacular, and it can be seen that they are not produced industrially; it is natural and tastes good." (Consumer, F) It is also referred to as not being heavily processed, compared to food from conventional distribution networks. Being natural also plays on an idea about nature as an essential category, which encompasses purity.

4.2 Discourse on organic certification

Consumer and producer thoughts about the value of food from Peasant Box and how it is conceptualised beyond standards and prescriptions on what defines good or safe food have been presented. In the absence of an official attestation of product quality, meanings about what food represents are created within the network, going beyond measurable qualities and include subjectively defined properties, like having an authentic taste, tasting like childhood, or being more natural.

In terms of certificates, the platform's initiators take an unequivocal stand, deeming an external authority's intervention to decide what is and what is not valuable as unnecessary. "These questions imply the presumption that food regulated and monitored by central authorities in the food industry is safe. Is this really true? I would say no, it's not." (Peasant Box, online blog) Thus, the platform is critical towards certificates, which are seen as an intrusive form of instrumentalisation of governmental power that is disruptive to the lives of small producers. They show how food industry regulations are created as a consequence of a food system driven by the desire for rising profits and falling costs, which characterises corporate agriculture. They

also draw attention to the difference in scale when discussing the producers from Peasant's Box, considering that small farmers have a direct relationship with the land and the people they sell to, so their motivation goes beyond a strictly utilitarian one. Thus, the initiators position themselves in favour of increasing trust by cultivating a direct relationship between producer and consumer. Consumers are invited to get directly involved in how the food is produced, i.e., to ask the producer, visit the farms, and communicate with the producer when something is not right.

There are no guarantees, the responsibility falls on all of us, including those who choose to join a box. If you really care about the quality of the food that is delivered to you, the Peasant's Box is actually an opportunity to do something about it. We encourage you to be careful and ask about the quality of the products you receive and then make informed decisions. "(Peasant Box Blog).

Interviews with consumers show that most are not interested in organic certificates, which are not considered decisive to food quality. From the consumers' perspective, the quality of products resides from an intersection of meanings regarding food. It is not limited to physical characteristics, including elements related to the symbolic value of food. Some consumers also point out that the certificates do not necessarily provide confidence, there being a dose of scepticism about their veracity.

"They don't promise you on the site that they are organic, eco and it doesn't matter as much as the fact that they are produced locally. I trusted that the food is ok, I also met the gentleman who cultivates it. Even at the supermarket, you don't necessarily have the guarantee, even if they are certified, you can't be sure, that they are the most eco-friendly products. But the food is good and tasty." (Consumer, F).

One consumer expressed that asking for certificates would go against the partnership principles, transforming the relations between consumer and producers into something more than simple market exchange. "I did not ask for certificates, actively not. Because that's part of the idea of a customer checking their seller." (Consumer, M).

The fact that organic certificates are not required by clients, who trust that the food is "clean" without the need for legitimacy from outside authorities is, of course, a benefit for producers, who can avoid additional costs and a long and complicated process of certification. When asked about obtaining organic certificates, the producers spoke primarily about their difficulties in obtaining them and the complicated procedures and standards. More generally, they spoke about the unpleasant experiences they had with state authorities, which created a great feeling of distrust, that added to their resistance to getting certificated.

"I also have relatives and friends in other countries, where there is talk of much greater support from the state. Besides, the authorities, and believe me, I know what I am talking about, when they come to control, they come to give fines, they also told us 'if we don't give fines, we are considered incompetent.' And there is nothing more to say." (Producer, F).

4.3 Building trust

Since producers are not urged to provide organic certificates to prove that the food they sell is produced with methods that are as minimally invasive as possible reveals the consumers' trust by virtue of the close relationship they develop. This status allows farmers to sell at premium prices as a form of "community economic rent" (Galt, 2013, p. 345), counteracting the exclusionary effect of certificates. Yet, it remains to be seen how trust is built and what makes the members of the Peasant's Box consider that the food they receive is as it is presented.

First, consumers motivate their confidence through their own sensory experience, namely through the taste of food. As reported, food has an authentic, true taste, as they remember from childhood, which gives them confidence that the food they eat is not industrially produced or imported. Apart from this aspect, consumers trust that food is safe because farmers consume their own products, which denotes that it is a safe and quality food. The following quote perfectly shows how trust is built and the extent to which a close relationship is necessary to make such networks work based on trust.

"There was a situation once when she brought us the

ISSN-Internet 2197-411x OLCL 862804632

"zacusca" [traditional Romanian speciality] that was spoiled, and I forgot to call her, to see what to do about it. And the lady came and asked us if the "zacusca" had been spoiled, that they had opened one can. I said yes, and that I forgot to tell her and she said she would bring me another one. So, it was a very nice gesture, there was no conflict, she didn't make us prove it or anything, she just brought us another one." (Consumer, F).

The interviewee expressed that they trusted the food to be good, without harmful chemicals based on this interaction because of two reasons. First, it was evident that the producers also consume the food, so it must be safe to eat, trusting the producers would not put their own family at risk. Secondly, the trust in the producer grew because the farmer contacted them when they found a spoiled batch, showing transparency and willingness to ensure consumer satisfaction. Trust is an essential element of the relationship between the participants of a CSA that is necessary for the function of this type of projects (Thorsøe & Kjeldsen, 2016). What sets apart the relationship through this network is the fact that it is kept informal. Moreover, the non-existence of a contract and, therefore, the informality of the relationship creates a trust that is significantly more important in the operation of the Peasant's Box.

Because being in a long-term relationship, it's not like at the market, where when someone buys something from you, you see them once and then never again. As a producer at Peasant's Box, you have weekly or monthly deliveries, and you get to see your clients again and again so you can't lie because if you cheat, they will still feel in the taste of the product. If you do your job, things go well on their own. (Producer, F)
No legal obligations are made, and at no point is the consumer obliged to keep their subscription, nor is the producer obliged to deliver anything in particular. Yet, without a formalised agreement, most of the partnerships have remained functioning for years. The informal aspect is backed by the initiators who view it as a central aspect in making the relationship more than a simple market exchange.

Transparency is an important aspect when building trust, so the producers make great efforts to make their production process as visible as possible for the consumers. The platform also encourages customers to be as involved as possible in maintaining this close relationship and questioning the production process.

5. Conclusions

The study has shown how the added value of food received through Peasant Box is perceived and how this type of network challenges an assumption regarding what good food is and how quality is defined. It is important to note that under the umbrella of alternative food networks, a multitude of organisation and governing practices differ in the degree of integration into the conventional distribution network. They must be understood as not falling into a distinct category from conventional networks but as being more or less integrated into them. When talking about alternative food networks, as many have pointed out (Corsi et al., 2018, p. 307), one should not assume that alternativeness automatically equals better or just. Thus, it is crucial to see to what extent these networks manage to challenge the logic of an economy based on globalisation, commodification and intensive industrialisation. As discussed, if organic or fair-trade certificates are thought of as a way to address the shortcomings of the global food system, tackling issues related to sustainability and social justice, they can just as quickly become instrumental for actors who use them as a form of limitation to form false rarity. Thus, we see that certificates do not manage to change the problematic practices existing in the food system but create a niche that can be exploited.

This paper demonstrates how these short networks counteract the exclusionary effects of certificates by re-introducing close relationships based on the trust between consumers and producers, addressing issues beyond food safety and environmental protection to include issues related to the principles underlying the exchange. It is important to remark that alternative food networks are not a monolith of practices, so researching them is important to consider the scale of the network and the level of social embeddedness, which can affect the network's underlying governing principles.

Thus, in the absence of imposed definitions regarding quality, people create their own rhetoric about what defines food as good. The food in this network is un-

derstood to be valuable both by the physical and the symbolic qualities it possesses. The discursive constructions regarding clean food were also discussed: the food authenticity, produced by peasants on the one hand, and the foods' more natural characteristics seen as healthier.

Funding: This work was funded by STAT-UBB Institute, Babes-Bolyai University, through the Special Scholarship for Scientific Activity 2019-2020.

Conflict of interest

The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results

References

Bîrhală, B., & Möllers, J. (2014). Community supported agriculture in Romania: Is it driven by economy or solidarity? Discussion paper no. 144, Leibniz Institute of Agricultural Development in Transition Economies.

Corsi, A., Barbera, F., Dansero, E., & Peano, C. (Eds.). (2018). Alternative food networks. McMillan: London.

Deac, S., Irimuş, I., & Păcurar, B. (2013). The landscape morphology of Cluj-Napoca residential neighbourhoods. Geographia, 58(2).

Galt, R. E. (2013). The moral economy is a double-edged sword: Explaining farmers' earnings and self-exploitation in community-supported agriculture. Economic Geography, 89(4), 341-365.

Goodman, D. (2003). The quality'turn'and alternative food practices: reflections and agenda. Journal of Rural Studies, 1(19), 1-7.

Goodman, D., DuPuis, E. M., & Goodman, M. K. (2012). Alternative food networks: Knowledge, practice, and politics. London: Routledge.

Guthman, J. (2004). Back to the land: the paradox of organic food standards. Environment and Planning A, 36(3), 511-528.

Guthman, J. (2008). Neoliberalism and the making of food politics in California. Geoforum, 39(3), 1171-1183.

Harris, E. M. (2010). Eat local? Constructions of place in alternative food politics. Geography Compass, 4(4), 355-369.

Hinrichs, C. C. (2000). Embeddedness and local food systems: notes on two types of direct agricultural market. Journal of Rural Studies, 16(3), 295-303.

Holloway, L., Kneafsey, M., Venn, L., Cox, R., Dowler, E., & Tuomainen, H. (2007). Possible food economies: a methodological framework for exploring food production–consumption relationships. Sociologia Ruralis, 47(1), 1-19.

Maye, D., & Kirwan, J. (2010). Alternative food networks. Sociology of Agriculture and Food, 20(3), 383-389.

Moellers, J., & Bîrhală, B. (2014). Community Supported Agriculture: A promising pathway for small family farms in Eastern Europe? A case study from Romania. Applied Agricultural and Forestry Research, 64(3/4), 139-150.

Moragues-Faus, A. (2017). Emancipatory or neoliberal food politics? Exploring the "politics of collectivity" of buying groups in the search for egalitarian food democracies. Antipode, 49(2), 455-476.

Order 895 from 2016. Romanian Ministry of Agriculture. Available online : chrome-extension://oemmndcbldboiebfnladdacbdfmadadm/https://www.madr.ro/docs/agricultura/agricultura-ecologica/ordin-nr-895-2016-22.02.2019.pdf

Petrovici, N. (2013). Neoliberal proletarization along the urban-rural divide in postsocialist Romania. Studia UBB Sociologia, 58(2), 23-54

Psarikidou, K. (2012). The moral economy of civic food networks in Manchester. The International Journal for the Sociology of Agriculture and Food, 19(3), 309-317.

ISSN-Internet 2197-411x OLCL 862804632

Renting, H., Marsden, T. K., & Banks, J. (2003). Understanding alternative food networks: exploring the role of short food supply chains in rural development. Environment and Planning A, 35(3), 393-411.

Renting, H., Schermer, M., & Rossi, A. (2012). Building food democracy: Exploring civic food networks and newly emerging forms of food citizenship. The International Journal of Sociology of Agriculture and food, 19(3), 289-307.

Thompson, E. P. (1971). The moral economy of the English crowd in the eighteenth century. Past & Present, 50(1), 76-136.

Thorsøe, M., & Kjeldsen, C. (2016). The constitution of trust: Function, configuration and generation of trust in alternative food networks. Sociologia Ruralis, 56(2), 157-175.

Watts, D. C., Ilbery, B., & Maye, D. (2005). Making reconnections in agro-food geography: alternative systems of food provision. Progress in Human Geography, 29(1), 22-40.

ISSN-Internet 2197-411x OLCL 862804632

Future of Food: Journal on Food, Agriculture and Society, 9 (2)

Constitutional complaints against the Federal Climate Change Act partially successful

Press Release No. 31/2021 of 29 April 2021

By www.bundesverfassungsgericht.de

Order of 24 March 2021
1 BvR 2656/18, 1 BvR 96/20, 1 BvR 78/20, 1 BvR 288/20, 1 BvR 96/20, 1 BvR 78/20

In an order published today, the First Senate of the Federal Constitutional Court held that the provisions of the Federal Climate Change Act of 12 December 2019 (Bundes-Klimaschutzgesetz – KSG) governing national climate targets and the annual emission amounts allowed until 2030 are incompatible with fundamental rights insofar as they lack sufficient specifications for further emission reductions from 2031 onwards. In all other respects, the constitutional complaints were rejected.

The Federal Climate Change Act makes it obligatory to reduce greenhouse gas emissions by at least 55% by 2030 relative to 1990 levels and sets out the reduction pathways applicable during this period by means of sectoral annual emission amounts (§ 3(1) and § 4(1) third sentence KSG in conjunction with Annex 2). It cannot be ascertained that the legislator, in introducing these provisions, violated its constitutional duty to protect the complainants from the risks of climate change or failed to satisfy the obligation arising from Article 20a of the Basic Law (Grundgesetz – GG) to take climate action. However, the challenged provisions do violate the freedoms of the complainants, some of whom are still very young. The provisions irreversibly offload major emission reduction burdens onto periods after 2030. The fact that greenhouse gas emissions must be reduced follows from the Basic Law, among other things. The constitutional climate goal arising from Article 20a GG is more closely defined in accordance with the Paris target as being to limit the increase in the global average temperature to well below 2°C and preferably to 1.5°C above pre-industrial levels. For this target to be reached, the reductions still necessary after 2030 will have to be achieved with ever greater speed and urgency. These future obligations to reduce emissions have an impact on practically every type of freedom because virtually all aspects of human life still involve the emission of greenhouse gases and are thus potentially threatened by drastic restrictions after 2030. Therefore, the legislator should have taken precautionary steps to mitigate these major burdens in order to safeguard the freedom guaranteed by fundamental rights. The statutory provisions on adjusting the reduction pathway for greenhouse gas emissions from 2031 onwards are not sufficient to ensure that the necessary transition to climate neutrality is achieved in time. The legislator must enact provisions by 31 December 2022 that specify in greater detail how the reduction targets for greenhouse gas emissions are to be adjusted for periods after 2030.

Please click here to read the full press release: https://www.bundesverfassungsgericht.de/SharedDocs/Pressemitteilungen/EN/2021/bvg21-031.html

More information: www.bundesverfassungsgericht.de

ISSN-Internet 2197-411x OLCL 862804632

A distortion of science and a danger to public and environmental safety

https://ensser.org/

26 April 2021

By ***Critical Scientists Switzerland and ENSSER***

The EASAC-endorsed Leopoldina Statement, demanding that the EU stops regulating 'genome-edited' plants, represents the narrow interests of 'genome editors' but it does not demonstrate the scientific objectivity or balance required, nor does it represent any consensus in the scientific community at large beyond the self-interested advocates. The EASAC-endorsed Leopoldina Statement is biased and does not withstand scientific scrutiny. ENSSER and CSS, in a scientific critique of the Leopoldina Statement, urgently call for stringent regulation of 'genome editing' to protect public and environmental safety. The so-called 'genome editing' techniques, just like the older techniques of genetic modification, give rise to known as well as inadvertently generated risks. Their potential for dual use, abuse and accidental misuse is considerably higher than that of the older techniques and warrants even stricter surveillance. So does their application as gene drives.

Please click here to read the full press release: https://ensser.org/press_release/press-release-a-distortion-of-science-and-a-danger-to-public-and-environmental-safety/

More information: https://ensser.org/

For more news please refer to our website

https://www.thefutureoffoodjournal.com/index.php/FOFJ/News

ISSN-Internet 2197-411x OLCL 862804632

Beyond the gap: Placing biodiversity finance in the global economy

A new interesting research report, **'Beyond the gap: Placing biodiversity finance in the global economy'**, published by the Third World Network and the University of British Columbia. The research demonstrates why structural patterns of trade, investment and financial regulation (or lack thereof), global economic pressures that push biodiverse countries into debt, and inequality across racialised, gender, class and colonial lines, must be addressed if we are serious about addressing biodiversity loss.

The Briefing Paper is currently available in English and Spanish.

For more information, please visit: https://twn.my/title2/finance/2021/fi210504.htm

To read the new research report: https://twn.my/title2/books/Beyond%20the%20Gap/BeyondTheGap%20complete%20report.pdf

For more news please refer to our website

https://www.thefutureoffoodjournal.com/index.php/FOFJ/News

ISSN-Internet 2197-411x OLCL 862804632

"Territories of Life: 2021 Report"

https://www.iccaconsortium.org/

Launch event on 20 May

The ICCA Consortium is pleased to invite you to the launch of their 2021 report on territories of life - a multimedia local-to-global analysis of territories and areas conserved by Indigenous peoples and local communities and their diverse contributions to a healthy planet. A summary for policymakers includes recommendations for the negotiation and implementation of the post-2020 global biodiversity framework.

The event will be held online on 20 May 2021 from 13:00-14:00 UTC. It will include simultaneous interpretation in English, French, and Spanish.

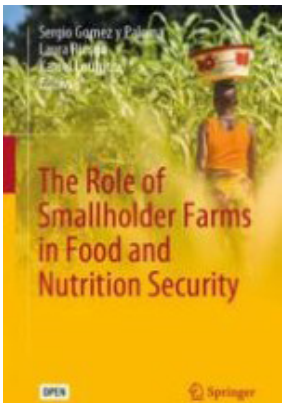
Please visit the ICCA Consortium website for registration and further information:

https://iccaconsortium-org.zoom.us/meeting/register/tJErdOiorTwtGdfnZlQTUqfrMuNZxA-gWgwn

For more news please refer to our website

https://www.thefutureoffoodjournal.com/index.php/FOFJ/News

Future of Food: Journal on Food, Agriculture and Society, 9 (2)



The Role of Smallholder Farms in Food and Nutrition Security

A review by Nayram Ama Doe

Authors (Eds.): Sergio Gomez y Paloma, Laura Riesgo and Kamel Louhichi
Publisher: Springer Nature Switzerland AG
Published year: 2020
Language: English
ISBN: 978-3-030-42148-9
Length: 262 pages

Food and nutrition security is globally rated as one very significant aspect of health, politics and government. Despite food availability, statistics show that billions of people still suffer from hunger and lack nutritious food. This book encompasses different sub-topics, such as why smallholders remain essential for food and nutrition security and how to support and provide opportunities to smallholder farmers. Furthermore, the role of smallholder farms in a changing world, rural development strategies, Africa's small farms and many other topics are addressed. However, this book review focuses on and discusses the role of smallholder farms in a changing world.

This book's first chapter begins with an introduction discussing how significant changes will need to be made to world agriculture in the approaching decades to meet the future and forthcoming food demands in a constantly growing and urban population. Smallholders in developing countries are significant stakeholders in playing a pivotal role in issues on food security due to their estimated provision of approximately 80% of food produced in Asia and sub-Saharan Africa.

Chapter two discusses the critical but shifting role of smallholders. Over time, there has been evolvement of ideas about smallholder farms, which is being seen more in the economic milieu. The author suggests that discussions and deliberations about smallholder farms should be taken a step further. The focus should extend beyond small farms versus large farms and rather reflect that the optimal size is dynamic. It changes based on a country's overall economic growth and the development of non-agricultural sectors.
The third chapter emphasises the typology of development pathways for smallholders. It is a fact that smallholder farms play a pivotal and substantial role in developing countries; therefore, policies that directly and indirectly affect smallholder farmers significantly affect the social and economical line of these countries. However, the author suggests that the suitable strategy for a livelihood should not be seen and treated as a solitary pathway but instead as a dynamic process that mirrors the different types of smallholder farms and economies. A typology has been created to reflect the possible livelihood strategies and development pathways for smallholder farmers to achieve this dynamic process. The aim is to distinguish between the profitability of smallholders within the agricultural sector, encompassing subsistence farmers with and without profit potentials and smallholder farmers, and the diverse and various stages of economic transformation, specifically agriculture-based, transforming and transformed economies.

Chapter four points out some challenges that hinder the profitability of smallholder farms. Despite the role of smallholder farmers in increasing production and aiding in reducing food and nutrition insecurity, these smallholder farms encounter a spectrum of challenges that could encumber the profitability of these farms. These challenges cause farmers to partake in lower-risk and lower-yielding agricultural activities that could prolong a cycle of poverty. Some challenges farmers face includes small and limited farm size, lower access to financial services, change in climate, price fluctuations, spikes and volatility, and lack of access to modern markets.

Chapter five deliberates on whether smallholder farms need to move up or out. It supports the idea of public policy supporting smallholder farmers moving up to either large scale profitable oriented farming systems or moving out of agriculture to find non-farm employment opportunities. This chapter advocates for public policies to support

ISSN-Internet 2197-411x OLCL 862804632

moving small scale farmers up, especially farmers who can make more profits through increased productivity. Such small-scale farmers should also be moved up by promoting high-value agriculture and building more links and global market connections. Some critical measures should be taken to promote the profit potential of smallholder farms towards tremendous success while enhancing food and nutrition security globally. Some of these include promoting land rights and efficient land markets, enhancing risk management, mitigation and adaptation strategies, supporting efficient and inclusive food value chains, closing gender gaps and developing young farmers, and lastly, scaling up productive cross-sector social safety nets.

The concluding chapter of this book, chapter six, emphasises the need for world agriculture to undertake main changes if the demands of an increasing population have to be met despite the scarcity and shortage of natural resources and other evolving challenges. This chapter also talks about how other farmers have an essential role in a developmental process and should be given the necessary support by closing gender gaps and developing young farmers, and supporting efficient and inclusive food value chains.
Overall, this book was very informative and educative as it discusses and enlightens readers on the function of smallholder farms in food and nutrition security. It gives in-depth knowledge on the importance of smallholder farmers in developing countries and the development pathways for smallholder farmers. This book can be recommended highly as a good read and a helpful resource.

About the author:

Nayram Ama Doe is a master's student at the University of Kassel and Fulda University of Applied Sciences, Germany, studying International Food Business and Consumer Studies. Her research focuses on food sustainability, international food legislation, agriculture, and food systems, and she is very passionate about food security and food supply chain issues.

CALL FOR PAPERS

Vol. 10, Number 1 2022

THE FUTURE OF FOOD JOURNAL
JOURNAL ON FOOD, AGRICULTURE & SOCIETY

Climate-smart agriculture

Scope:

Climate-smart agriculture involves farming practices that improve farm productivity and profitability, help farmers adapt to the negative effects of climate change, and mitigate climate change effects, e.g., by soil carbon sequestration or reductions in greenhouse gas emissions. It is a pathway towards development and food security built on three pillars: increasing productivity and incomes, enhancing the resilience of livelihoods and ecosystems, and reducing and removing greenhouse gas emissions from the atmosphere. Climate-smart practices include practices with an explicit focus on adaptation and practices with a broader scope on reducing production risks and reducing emissions.

The proposed issues will focus on climate-smart approaches that include, but not limited to, increasing diversity, improving sustainable soil and land management, increasing energy use efficiency, and promoting sustainable mechanization.

Publication time: this issue is planned to be published during the **1st quarter of 2022**

Author Guidelines and Manuscript Submission can be found at:

http://www.thefutureoffoodjournal.com/index.php/FOFJ/information/authors

Please note that we are still publishing according to the online-first system, which means that when your paper is ready to be published, it will be first published online, then it will be included later in the issue when the whole issue is ready to be online.

Feel free to contact us if you would have any questions.

Best wishes,

Editors of Future of Food Journal

Follow us on Facebook
@futureoffoodjournal

CALL FOR PAPERS

Vol. 10, Number 2 2022

THE FUTURE OF FOOD JOURNAL
JOURNAL ON FOOD, AGRICULTURE & SOCIETY

Agro-based Bioeconomy

Scope:

The bioeconomy is defined as the production, utilization, conservation, and regeneration of biological resources. It is an economic sector primarily based on biogenic instead of fossil resources, and which is increasingly prevalent in policymaking across the globe. Agriculture is one of the essential fields of bioeconomy as it brings together various sectors of food systems, including agriculture, forestry, fisheries , and aquaculture, as well as food and feed manufacturing occupy the biggest niche of the bioeconomy.
The proposed issue will focus on topics that include, but not limited to, the integrated approach for sustained innovation in various areas of agro-based bioeconomy, production of renewable biological resources and their conversion into food, feed, bio-based products and bioenergy, agriculture, forestry, fisheries, food production, as well as parts of chemical, biotechnological and energy industries.

Publication time: this issue is planned to be published during the **2nd quarter of 2022**

Author Guidelines and Manuscript Submission can be found at:

http://www.thefutureoffoodjournal.com/index.php/FOFJ/information/authors

Please note that we are still publishing according to the online-first system, which means that when your paper is ready to be published, it will be first published online, then it will be included later in the issue when the whole issue is ready to be online.

Feel free to contact us if you would have any questions.

Best wishes,

Editors of Future of Food Journal

Follow us on Facebook
@futureoffoodjournal

CALL FOR PAPERS

Vol. 10, Number 3 2022

THE FUTURE OF FOOD JOURNAL
JOURNAL ON FOOD, AGRICULTURE & SOCIETY

Marketing and consumers behaviour

Scope:

Consumers' behaviour has been the core of attention of researchers in food marketing. The power of companies economy is built on their ability to sell products and services and understand consumers' motivations to purchase products and services. However, consumers differ in their purchase motivations, susceptibility to marketing attempts, and decision-making strategies. Much research nowadays ignores this fact.

Studying consumer behaviour is essential for marketers to understand what influences consumers' buying decisions and final choices. By understanding how consumers decide on a product, they can fill in the gap in the market and identify the products that are needed and the products that are obsolete.

The proposed issue will focus on topics that include, but not limited to, how people make decisions about what they buy, want, need, or act in regards to food or agricultural products or services, factors that affect consumers' behaviour ', including psychological, personal and social factors, behaviour of consumers while researching and shopping, the influence of the environment on consumer behaviour, how marketing campaigns can be adapted and improved to more effectively influence the consumer.

Publication time: this issue is planned to be published during the **3rd quarter of 2022**

Author Guidelines and Manuscript Submission can be found at:

http://www.thefutureoffoodjournal.com/index.php/FOFJ/information/authors

Please note that we are still publishing according to the online-first system, which means that when your paper is ready to be published, it will be first published online, then it will be included later in the issue when the whole issue is ready to be online.

Feel free to contact us if you would have any questions.

Best wishes,

Editors of Future of Food Journal

Follow us on Facebook
@futureoffoodjournal

CALL FOR PAPERS

Vol. 10, Number 4 2022

THE FUTURE OF FOOD JOURNAL
JOURNAL ON FOOD, AGRICULTURE & SOCIETY

Sustainable nutrition systems

Scope:

A sustainable nutrition system is a key to reforming our global food system. As studies and statistical projections have shown, in 2050, the world population is estimated to reach approximately 9.8 billion people, and therefore the question is always: How can we feed them all? Our current diet will not answer the previous question. The current diet depends largely on increasing production, ignoring all other factors. Whereas, we must rethink the method of cultivation used, the amount of production, distribution, and household consumption.

The proposed issue will focus on topics that include, but not limited to, promote an effective, sustainable nutrition system that reduces environmental impacts, confronts the environmental challenges, and improves health and nutritional outcomes, and helps produce nutrient-rich foods

Publication time: this issue is planned to be published during the **4th quarter of 2022**

Author Guidelines and Manuscript Submission can be found at:

http://www.thefutureoffoodjournal.com/index.php/FOFJ/information/authors

Please note that we are still publishing according to the online-first system, which means that when your paper is ready to be published, it will be first published online, then it will be included later in the issue when the whole issue is ready to be online.

Feel free to contact us if you would have any questions.

Best wishes,

Editors of Future of Food Journal

Follow us on Facebook
@futureoffoodjournal

Call for Reviewers

THE FUTURE OF FOOD JOURNAL
JOURNAL ON FOOD, AGRICULTURE & SOCIETY

Future of Food Journal is opining now a Call for Reviewers. Join us in our effort to reduce the manuscript processing lead time!

As the peer-review process is a fundamental criterion in scientific publication, the number of qualified reviewers is declining when the number of submissions is increasing. We are looking to expand our team of expert peer reviewers in the fields of:

1- Sustainable Agriculture
2- Sustainable Food system
3- Food Production & Technology
4- Nutrition and Diets
5- Environmental and Climate Sciences
6- Consumers Behaviour

And we would be delighted for you to join our team.

What to expect being a reviewer at FOFJ:

1- A great scientific experience
2- An acknowledgement in one of our published issues after the completion of 5 reviews
3- The opportunity to join the Editorial Board when a call for members is open
4- 100 € after the completion of 5 reviews

Your duties would be to:

1- Review the assigned paper within max. 3 weeks
2- Review the manuscript once it has been accepted and revised within max. 1 week

Looking forward to receiving your application.

Please follow the link below for the new online registration process:

https://www.thefutureoffoodjournal.com/index.php/FOFJ/user/callReviewer

Thank you Reviewers

THE FUTURE OF FOOD JOURNAL
JOURNAL ON FOOD, AGRICULTURE & SOCIETY

FOFJ appreciates the efforts and experience of all its highly qualified reviewers who contribute to the science and quality of research. Therefore, FOFJ thanks all the reviewers who dedicate time, knowledge, and effort to improve the quality of submitted manuscripts.
In this issue, FOFJ would like to extend a sincere Thanks to our reviewers **Dr. Babatunde Olarewaju, Dr. Condro Wibowo and Dr. George Horváth** for their contribution in reviewing articles for Vol 8 and Vol 9. As FOFJ launches a new Call of Reviewers, we hope to continue working with experienced academics to provide the best for our readers and authors.

Dr. George Horváth is an economist, with a specialisation in natural resource management. Later, he also completed his specialisation in urban and rural development. He obtained his PhD in 2017, with his thesis focusing on grassroots initiatives for the sustainability transition. Currently, his research interests include sustainability initiatives in small rural communities, and an increased sharing of scarce, depletable resources. Through his work, he aims to bridge the gaps between territorial governments, businesses and citizens for a more harmonious development.

Since 2019, Dr. Horváth has been involved with research into food waste prevention and reduction, and he is seeking out ways of coming up with novel solutions and approaches to tackle this problem, once again through bridging the gaps between governments, businesses and citizens.

Dr. Horváth is a passionate and experienced lecturer, who is dedicated to help talented young minds develop to their full potential. His teaching portfolio includes the economics of sustainable development, natural resource management, municipal management and territorial governance.

Dr. Condro Wibowo is an expert on Food Science and Technology, he obtained the Master and Doctoral degree from the Georg-August University Goettingen Germany. Recently, his affiliation is Department of Food Technology, Faculty of Agriculture, Jenderal Soedirman University (UNSOED) Indonesia. He is a member of the Indonesian Association of Food Technologist (IAFT), Indonesian Society for Nutraceutical and Functional Food (ISNFF), Sustainable Agriculture Food and Energy (SAFE) Network and International Society of Organic Farming Research (ISOFAR).

His research interests are: Examining the quality of agricultural products, Postharvest Technology, Food processing, Food packaging, Biodegradable film and coating. He published articles related to his expertise in the journals of agricultural and food sciences. He serves as the reviewer for several reputable journals. Moreover, he has been working with other scientists in national or international research projects about food science and technology.

Thank you Reviewers

THE FUTURE OF FOOD JOURNAL
JOURNAL ON FOOD, AGRICULTURE & SOCIETY

Dr. Babatunde Olarewaju is a Food safety expert with B.Agric and Master of Philosophy (M.Phil) Degrees in Agricultural Extension and Rural Sociology

His interests are in Food Safety Management System, Quality Management System, training, youth capacity building and development, gender equity, and community driven development projects and consulting. He is currently the Lead Strategist of FutuX Agri-consult Limited, a private agricultural extension firm in Nigeria.

Babatunde had worked under different national and international projects with Action against Hunger, Palladium, Bill and Melinda gates Foundation, SADC Research centre, IFAD/FGN (VCDP), REGIC, El-Tayeb Trading Co. Ltd. Amongst others.

He was a licensed GlobalG.A.P Farm Assurer, Quality Management System (QMS), and GlobalG.A.P Risk Assessment on Social Practice (GRASP) till July 2020, and currently, a PECB certified ISO 22000 (Lead auditor) and had few articles published in International journals