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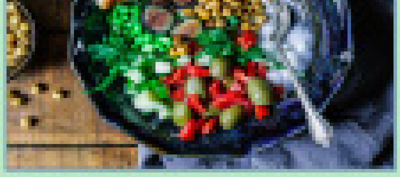

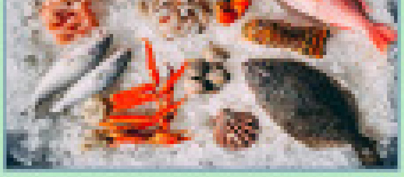

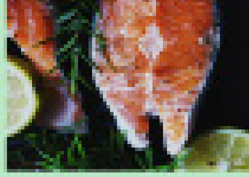

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Editorial

Climate-Smart Agriculture: Adapting to a Changing Climate for Sustainable Food Production"

Muhammad Qasim Ali obtained his B.S. degree in Agri-Food Technology from the University of AJK Muzaffarabad, Pakistan. During the early of his career, he worked in a multinational food company as a Quality and safety officer. He was appointed Graduate Research Assistant (2022) at the University Malaysia Pahang for his Doctor of Science degree. During his PhD program, he worked at Seaweeds Bioprocessing, food quality and safety. Currently, he actively aspires to secure a Post Doc position. His research interests encompass Food (processing, Biotechnology, Halal food, safety, and preservation) and Food security and agriculture.

Fighting hunger ranks among the most difficult tasks of our period. This endeavour is further complicated by the impact of climate change, which is progressively influencing primary food production and broader food systems. Simultaneously, the agriculture and land use sectors significantly contribute to the overall greenhouse gas emissions on a global scale. The capacity of our natural resources to sustain future populations' food needs, particularly in the year 2050. It assesses global land use, water use, and fertilizer use for various dietary scenarios. The findings underscore the pressing need for substantial agricultural development to meet future food demands (Odegard & van der Voet, 2014).

Climate-smart agriculture represents a holistic and forward-thinking approach to addressing the challenges posed by climate change to agriculture and food security. By integrating adaptation, mitigation, resource efficiency, and policy support, CSA offers a promising pathway to not only safeguard our food supply but also contribute to global efforts to combat climate change. It underscores the necessity of adapting our agricultural systems to a changing climate while simultaneously working toward a more sustainable and resilient future for agriculture and food production.

Climate-smart agriculture offers a comprehensive strategy for addressing these interconnected challenges, with a focus on three core goals: enhancing productivity and income sustainability, bolstering resilience and adapting to climate change, and minimizing greenhouse gas emissions wherever feasible. The implementation process of CSA follows a structured framework comprising five key steps. It commences with building an evidence base and progresses through enhancing supporting policies, institutions, and financial mechanisms, ultimately culminating in on-the-ground implementation. Within the agricultural sector, encompassing crop and livestock production, fisheries, aquaculture, and forestry, as well as the management of land and water resources, and the various stages of food value chains, each faces distinctive challenges concerning the three CSA objectives while also exhibiting inter dependencies. To formulate successful strategies and production systems facilitating the shift towards climate-smart food systems, fostering resilient livelihoods for food producers, and advancing the global mission to eradicate hunger, it is imperative to possess a thorough comprehension of these challenges, recognize the interconnections within food systems, and foster coordination across various fields and sectors (Matteoli et al., 2020).

Climate-smart agriculture (CSA), A case study encompassing 24 initiatives across Africa, with a particular focus on the following core areas for in-depth examination, was conducted. These areas include: Climate-Smart Village Approach, Climate Information Services and Science-Policy Integration. The analysis of these case studies revealed that CSA can play a pivotal role in driving transformative changes within African food systems by: By adopting pertinent climate-smart technologies and practices, it is possible to redirect farming and rural livelihoods toward climate-resilient and low-emission pathways. The creation and application of WCIS can contribute to risk reduction in livelihoods, farms, and value chains in response to the growing unpredictability of weather and extreme events. Embracing climate-smart options that reduce waste in the production, processing, packaging, transportation, and marketing of food can mitigate the associated carbon footprint. It involves reshaping policies and financial mechanisms to facilitate action in these four core areas. This includes identifying innovative ways to mobilize sustainable finance and create effective financial channels (Zougmoré et al., 2021).

In this context, Climate-Smart Agriculture (CSA) plays a crucial role in bolstering crop production through a combination of adaptation and mitigation strategies. CSA actively contributes to the establishment of agricultural systems that are resilient to climate change. For example, it enhances soil quality, optimizes the efficient utilization of water and nutrients, and promotes stable crop yields while simultaneously curbing emissions associated with the Sustainable Development Goals. Despite the widespread recognition of the advantages of CSA, there exists a scarcity of comprehensive assessments regarding the full potential of CSA techniques for both adaptation and mitigation, and the existing evaluations remain scattered and incomplete (Abhilash et al., 2021).

Agriculture 4.0 incorporates an array of technologies, including Internet of Things (IoT) systems, deep learning techniques, and machine learning methods. These technologies are deployed to efficiently monitor and manage various agricultural processes. Smart agriculture is significantly improving the productivity and efficacy of the agricultural sector through various means. Nevertheless, there exist several challenges that must be addressed to make it economically viable for small and medium-scale farmers. The primary considerations include security and affordability. The anticipated growth in the adoption of IoT technology in agriculture can be attributed to increased competition within the sector and the implementation of favourable policies. The strategic use of advanced technology can play a substantial role in advancing food sustainability for both present and future generations by optimizing the utilization of available resources and assets (Raj et al., 2021).

Beyond its technical and economic aspects, climate-smart agriculture raises ethical questions about the equitable distribution of benefits and adaptation strategies.

1. Plant diverse crops to reduce vulnerability to changing climate conditions. Crop rotation and intercropping can enhance resilience and soil health. Develop and utilize crop varieties bred for climate resilience. These varieties can better withstand temperature extremes, pests, and diseases.

2. Implement efficient irrigation systems, rainwater harvesting, and drought-resistant crop varieties to conserve water resources. Adopt conservation tillage practices to reduce soil erosion and enhance soil fertility. Cover cropping and agroforestry can improve soil health.

3. Integrate natural ecosystems into agricultural landscapes to provide ecosystem services, such as pollination and pest control. Utilize climate data and forecasts to make informed decisions on planting and harvesting times, reducing climate-related risks.

4. Explore practices like agroforestry and cover cropping to sequester carbon in soils, mitigating climate change.

5. Minimize food waste through improved post-harvest handling and storage practices. Governments should create policies that incentivize CSA practices, such as providing subsidies for climate-resilient crop varieties and promoting sustainable land use.

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6. Invest in research to develop innovative CSA practices and educate farmers about their benefits. Establish financial mechanisms such as crop insurance and credit schemes to help farmers cope with climate-related losses.

7. Encourage community involvement in CSA initiatives, fostering knowledge sharing and collaborative efforts.

8. Promote the adoption of climate-smart technologies, including precision agriculture tools and weather-resistant infrastructure.

9. Implement sustainable livestock practices, including rotational grazing and improved feed efficiency, to reduce the environmental impact of animal agriculture.

10. Facilitate market access for small-scale farmers practising CSA, ensuring they receive fair prices for their products.

11. Encourage international cooperation to address climate change and food security challenges through initiatives like the Paris Agreement and the United Nations Sustainable Development Goals.

The african government has created many plans and strategies to combat climate change, but they are not properly carried out. In the long run, appropriate strategies and regulations for climate change should be created and properly executed because climate change significantly impacts agriculture production. Therefore, sustainable practices must be considered and put into action for the benefit of farmers, the environment, and food security.

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Effect of Different Treatments on Storage Quality of Celery Petioles

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Data of the article

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Keywords

Celery; Mixed Gases; Browning; Fresh-cut; Heat Treatment; MAP; Chitosan; Colour of petioles.

This study was conducted for two seasons 2021 and 2022 to evaluate the influence of the hot water at 45° C and 50° C, chitosan at 0.5%, and active modified atmosphere packaging (MAP) at 5% O_2 + 5% CO_2, 5% O_2 + 10% CO_2 and passive MAP presented as the control on quality attributes and browning of fresh-cut celery petioles during storage at 0° C for 16 days. The results indicated that all treatments were effective in reduced weight loss, colour changes, discolouration, chlorophyll loss, total microbial count, polyphenol oxidase activity and maintained total phenolic content and total chlorophyll and overall appearance of fresh-cut celery petioles as compared with passive MAP (control). Fresh-cut celery petioles treated with hot water at 45° C and 50° C and active MAP at 5% O_2 + 5% CO_2 were the most effective treatments in maintaining quality during all storage periods. However, samples treated with hot water at 45° C showed the best quality avoided the loss of green colour, retarded the growth of microorganisms, not exacted any browning in the cut surface of petioles and did not exhibit any changes in general appearance till the end of storage period (16 days of storage at 0° C), while hot water at 50 ° C and active MAP at 5% O_2 + 5% CO_2 rated good appearance at the same period.

1. Introduction

Fresh-cut of celery petioles provide a lot of benefits such as reduced risk of cancer and cardiovascular disease (Heim et al., 2003) and benefits for consumers and producers. Petioles are cut immediately after harvest and they are used as snacks on the run. Petioles of celery are highly perishable to decay, loss of green colour and to development of pithiness which is transformed into the parenchyma. The general appearance of pithiness is whitish regions and air space within the tissue, so, the quality and shelf life of celery are decreased (Saltveit and Mangrich 1996 and Viña and Chaves 2006).

One of the most problems affecting celery is postharvest browning at cut surfaces; this is a physiological disorder. The phenomenon basically appears on cut or damaged surfaces manifesting itself with black/brown pigments. Browning of the product loses its freshness and tends to be considered as a decayed or diseased product. This results in considerable economic losses as sales decrease because the product does not meet supermarket specifications. Cutting also results in nutrient leakage from cells and increased water vapour and gas permeability (Gómez and Artés 2005).

Some physical methods such as hot water treatment

(Loaiza-Velarde et al., 2003 and Bablar et al., 2022), Modified Atmosphere Packaging (Gómez and Artés 2005) and edible coating treatments (Raymond et al., 2012) have been applied as postharvest treatment to preserve the quality and prevent the browning of celery petioles during cold storage.

Chitosan coating is a flexible transparent and can function as a barrier to water vapour, gases, and other solutes and also as a carrier of many functional ingredients, such as antimicrobial and antioxidant agents, thus enhancing the quality and extending the shelf life of fresh and minimally processed fruits and vegetables (Shiekh et al., 2013). Chitosan has been applied successfully as a coating on food surfaces to extend shelf life effectively without compromising the natural taste of the product (Kumar et al., 2020). Also, chitosan contends a beneficial effect on reducing decay, weight loss, colour changes, loss of firmness, delayed softening of fruits (Raymond et al., 2012).

There are a lot of new solutions to slow down the physiological processes, and disorders and minimize microbial growth in fresh-cut celery petioles such as modified atmosphere and hot water treatments. This has been shown to have good control in the metabolism of tissues and maintaining the quality of products (Loaiza-Velarde et al., 2003, Xing et al., 2011, Xing et al., 2019 and Babalar et al., 2022). Additionally, hot water treatment reduced the phenylalanine ammonia-lyase activity (PAL), the accumulation of phenolic compounds, and inhibits the browning, Abdalla 2013, Kobayashi et al., 2021 and Babalar et al., 2022). Modified atmosphere packaging (MAP) is an atmosphere created around produce that is different from that of air, which brings beneficial effects like an extension of the shelf life of fresh produce. MAP can be passively created by the commodity itself through the respiration process wherein oxygen is consumed and carbon dioxide is evolved or actively by flushing in gases of known composition (Kader 2002 and Kobayashi et al., 2021). Depleted O_2 and/or enriched CO_2 levels of the tissue, so, the hot water treatment maintains the quality and inhibits the browning reaction and extends the shelf life of the product) Loaiza-Velarde et al., 2003) can reduce respiration, delay ripening, decrease ethylene production, retard textural softening, slow down compositional changes associated with ripening (Gómez and Artés 2005), thereby resulting in an extension in a shelf life (Kobayashi et al., 2021).

Cantwell and Suslow (2002) and Gómez and Artés (2005) recommended using the MAP of celery petioles which should be designed to maintain both O_2 and CO_2 as close as possible to these levels (2 to 5 kPa O_2 and 5 to 10 kPa CO_2 atmospheres at 2–4°C).

Minimally processed celery petioles stored at MAP treatments can improve the quality attributes, avoided loss of fresh green colour, and decreased the development of pithiness and minimize microbial growth, no off-odours and off-flavours (Gómez and Artés 2005 and Kobayashi et al., 2021). The present study investigated the effect of hot water, MAP and chitosan coating as a postharvest treatment on quality attributes and browning control of fresh-cut celery petioles during storage.

2. Materials and methods

2.1. Plant Material

A white variety of celery plants (Apium graveolens L.) cv, Royal Crown was grown in greenhouse conditions at the farm of Cairo University, Giza Governorate during two successive seasons 2021 and 2022. Once the plants reached commercial size (after about 2 months of being transplanted), they were harvested 4th and 6th December in the first and the second season, respectively, and brought to the laboratory and immediately cut. Leaves and basal segments of the rosettes were eliminated to obtain straightened petioles. They were washed in running drinking water to remove any soil residues, and subsequently cut with a sharpened knife in 20-cm long petioles. Chitosan solution (0.5%) was prepared by dissolving 5 grams in one litre of distilled water.

Immediately after cutting they were immersed in chlorinated water (100 ppm active chlorine) for 3 min. Four treatments were applied as the following; celery petioles dipped in distilled water (control), chitosan solution at 0.5%, hot water at 45° and 50° C for one min. to all treatments (ambient temperature is 20 to 25° C). All the previous treatments were air-dried and packed in trays sealed with polypropylene bags 30 mμ. thickness. As for the two treatments, it flushed with different gases at 5% O_2 + 5% CO_2 and 5% O_2 + 10% CO_2.

Each bag for all treatments contains 100 grams as an

experimental unit and is stored at 0ºC (±1º C) and 95% relative humidity (RH). Randomly taken the three replicate samples. The following characteristics were examined at intervals (0, 4, 8, 12 and16) days:-
Weight Loss Percentage (%): the percentage of weight loss was assayed according to the description of Zhan et al., (2013).

General Appearance (GA): GA was evaluated using a scale from (1-9) with 9= excellent, 7= good, 5= fair, 3= poor, 1= unsalable and fruits rating (5) or below were considered unmarketable (the panel tests for general appearance, decay and chilling injury, evaluated by seven researchers at the postharvest vegetable lab.).
Colour: The colour was measured by using a camera Minolta CR-400 Chroma Meter (Minolta Co. ltd. Osaka, Japan) on two sides of cut petioles (outer and inner). Skin colour was measured and gloss was expressed in chromaticity values such as lightness (L) and b values, respectively. Three readings were taken at different locations of each fruit (Xing et al., 2011 and Xing et al., 2019).

Discolouration: Discolouration was evaluated on a scale of 1 to 5 where 1 = none, 2 = slight, 3 =moderate, 4 = severe and 5 = extra severe.

Chlorophyll Content Assay: according to the description Zhan et al., (2013) chlorophyll content was analysed with slight modification. According to the formulas of Lichtenthaler and Wellburn (1983), the chlorophyll a and chlorophyll b contents were calculated.

Microbiological Analysis: Total plate count was determined using plate count agar media. Plates were incubated at 35 ºC for 48±2 h (Andrews, 1992).

Enzyme Assay PPO Activity: PPO activity was determined by the method of (Saleh et al., 2013) with the following modification. The results were expressed as a percentage of the activity of the respective zero experiments.

Determination of Phenolic Compounds: The total phenols were quantified with the Folin–Ciocalteu reagent (Singleton et al., 1999). Absorbance readings were carried out at 760 nm in a spectrophotometer (Shimadzu U V-2401 PC, Kyo to, Japan).

Statistical Analysis: For each parameter at each storage time, the measurement was carried out three times. The collected data were submitted for analysis of variance using SPSS (version 11.0). One-way ANOVA was applied to compare the effect of treatments on measured parameters during storage using the least significant difference (LSD) test at 0.05 confidence level.

3.Results

3.1. Weight Loss Percentage

Data in Table (1) showed that the weight loss percentage of celery petioles increased consistently with the prolongation of storage periods.

All postharvest treatments reduced the loss of weight during storage. Moreover, the most effective treatments in reducing the weight loss% with no significant differences between them were MAP at 5% O_2 + 5% CO_2, hot water at 45°C or 50°C followed by MAP at 5% O_2 + 10 % CO_2, and chitosan at 0.5 % treatments with no significant differences between them. The control sample gave the highest values of weight loss.

The interaction between storage periods and postharvest treatments was significant; after 16 days of storage, the lowest value of weight loss was recorded in celery petioles treated with MAP at 5% O_2 + 5% CO_2, 0.17 and 0.15 percent in the first and second seasons, respectively. While, the highest ones were obtained from the control. 1.21 and 1.10 present in the first and second seasons respectively.

3.2. General appearance (GA)

Data in Table (2) show that there was a significant reduction in the general appearance (score) of celery petioles during cold storage periods.

Celery petioles treated with all treatments had significantly higher scores of appearance as compared with the control which recorded a lower score of GA and deteriorated rapidly. However, celery petioles treated with hot water at 45°C or 50°C and MAP at 5% O_2 + 5% CO_2 were the most effective for maintaining GA with no significant differences between them followed by MAP at 5% O_2 + 10 % CO_2 and chitosan at 0.5 % treatments with no significant differences between them, while control recorded the lowest ones.

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In widespread, the interplay between postharvest treatments and storage periods was significant. Outcomes recorded that celery petioles dipping in hot water at 45°C treatment gave an excellent appearance and did not exhibit any changes in this appearance until the end of the storage period (16 days of storage at 0°C) (score 8.33 in both seasons), but celery petioles dipping in hot water at 50°C and MAP at 5% O_2 + 5% CO_2 rated good appearance (score 7.0) in both seasons at the same period. While MAP at 5% O_2 + 10% CO_2 treatment gave a good appearance (score 7.67) in both seasons after 12 days from storage. On the other hand, the control had an unsalable appearance (score 1.67 in both seasons) after 16 days of storage at 0°C.

3.3. Colour (L value)

adjustments in lightness (L value) were found at the end of storage as compared to the initial value. The lightness of fresh-cut celery petioles changed into suffering from storage time. A decrement in L value become detected by using prolonging the storage pe-

Table 1: Effect of some postharvest treatments on weight loss (%) of fresh-cut celery during storage at 0°C in 2021 and 2022 seasons.

	After 4 days	After 8 days	After 12 days	After 16 days	Mean
2021					
45° C	0.03 F	0.07 EF	0.17 D-F	0.21 D-F	0.12 C
50° C	0.01 F	0.13 EF	0.18 D-F	0.20 D-F	0.13 C
CO2 5% + O_2 5%	0.03 F	0.10 EF	0.12 EF	0.17 D-F	0.11 C
CO2 10%+ O_2 5%	0.00 F	0.20 D-F	0.30 D-F	0.40 C-E	0.23 B
Chitosan	0.16 D-F	0.21 D-F	0.40 C-E	0.50 CD	0.32 B
Control	0.20 D-F	0.70 BC	1.02 AB	1.21 A	0.78 A
mean	0.07 C	0.23 B	0.37 AB	0.45 A	
2022					
45° C	0.11 F-J	0.06 IJ	0.13 F-J	0.18 E-J	0.12 D
50° C	0.04 IJ	0.11 F-J	0.22 C-J	0.25 C-I	0.15 CD
CO2 5% + O_2 5%	0.02 J	0.09 G-IJ	0.11 F-J	0.15 F-J	0.09 D
CO2 10%+ O_2 5%	0.07 H-J	0.19 D-J	0.30 C-G	0.42 C	0.25 BC
Chitosan	0.13 F-J	0.28 C-H	0.32 C-F	0.38 C-E	0.28 B
Control	0.13 F-J	0.40 CD	0.87 B	1.10 A	0.63 A
mean	0.08 D	0.19 C	0.32 B	0.41 A	

Means in the same column having the same letter are not significantly different at 0.05 level by Duncan"s multiple rang test.

Table 2: Effect of some postharvest treatments on general appearance (score) of celery during storage at 0°C in 2021 and 2022 seasons.

	After 0 day	After 4 days	after 8 days	after 12 days	after 16 days	mean
2021						
45ºC	9.00 A	9.00 A	9.00 A	8.33 AB	8.33 AB	**8.73 A**
50ºC	9.00 A	9.00 A	9.00 A	7.67 A-C	7.00 B-D	**8.33 A**
CO_2 5% + O_2 5%	9.00 A	9.00 A	9.00 A	7.67 A-C	7.00 B-D	**8.33 A**
CO_2 10%+ O_2 5%	9.00 A	8.33 AB	7.67 A-C	6.33 CD	5.67 D	**7.40 B**
Chitosan	9.00 A	7.00 BCD	6.33 CD	7.00 B-D	6.33 CD	**7.13 B**
Control	9.00 A	7.00 BCD	5.67 D	3.67 E	1.67 F	**5.40 C**
mean	**9.00 A**	**8.22 B**	**7.78 B**	**6.78 C**	**6.00 D**	
2022						
45º C	9.00 A	9.00 A	9.00 A	8.33 AB	8.33 AB	**8.73 A**
50º C	9.00 A	9.00 A	9.00 A	7.67 A-C	7.00 B-D	**8.33 A**
CO_2 5% + O_2 5%	9.00 A	9.00 A	9.00 A	7.67 A-C	7.00 B-D	**8.33 A**
CO_2 10%+ O_2 5%	9.00 A	8.33 AB	7.67 A-C	6.33 CD	5.67 D	**7.40 B**
Chitosan	9.00 A	7.00 B-D	7.00 B-D	7.00 B-D	6.33 CD	**7.27 B**
Control	9.00 A	7.00 B-D	6.33 CD	3.67 E	1.67 F	**5.53 C**
mean	**9.00 A**	**8.22 B**	**8.00 B**	**6.78 C**	**6.00 D**	

Means in the same column having the same letter are not significantly different at 0.05 level by Duncan‟s multiple rang test

riods (Table 3), resulting in a darker colour. However, all applied treatments show significantly higher L values compared with the control. Furthermore, fresh-cut celery petioles dipped in hot water at 45ºC and MAP at 5% O_2 + 5% CO_2 61.02 and 55.45 (average in the two seasons respectively) being the most effective treatments in maintaining the L values, resulted in lighter colour followed by hot water, 50º C and chitosan with significant differences between them during storage, while control gives the lowest one of L values during storage, resulted in a darker colour.

3.4. Discoloration

Data in Table (4) indicated that there was an increment in discolouration (score) for the cut surface of celery petioles during cold storage.

All the used treatments reduced the incidence of discolouration compared to the control. Fresh-cut celery treated with hot water at 45º or 50º C and MAP at 5%O_2 + 5% CO_2 were the most effective treatments in this concern followed by chitosan treatment. MAP at 5%O_2 + 10% CO_2 was less effective in reducing the incidence of discolouration.

The interaction between treatments and storage periods was significant after 16 days of storage. Celery petioles treatment with hot water at 45º and MAP at 5%O_2 + 5% CO_2 did not show any changes in their colour till the end of storage periods (16 days). The sample treated with hot water at 50º C showed none to a slight score of 1.67 in both seasons, and chitosan

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Table 3: Effect of some postharvest treatments on color (L. value) of fresh-cut celery during storage at 0°C in 2021 and 2022 seasons.

	After 0 day	After 4 days	after 8 days	after 12 days	after 16 days	mean
2021						
45° C	68.11 A	67.22 A	64.15 BC	61.22 D	60.00 D	**64.14 A**
50° C	68.11 A	64.62 BC	58.22 E	55.32 GH	53.10 IJ	**59.87 C**
CO_2 5% + O_2 5%	68.11 A	65.24 B	61.31 D	57.48 EF	54.62 HI	**61.35 B**
CO_2 10%+ O_2 5%	68.11 A	61.48 D	53.23 IJ	52.22 JK	48.30 L	**56.67 E**
Chitosan	68.11 A	63.41 C	56.40 FG	54.25 HI	50.70 K	**58.57 D**
Control	68.11 A	47.30 L	42.11 M	39.16 N	31.42 O	**45.62 F**
mean	**68.11 A**	**61.54 B**	**55.90 C**	**53.28 D**	**49.69 E**	
2022						
45° C	69.80 A	68.33 B	65.53 DE	62.73 F	62.04 F	**65.69 A**
50° C	69.80 A	67.23 BC	60.40 G	56.59 I	54.86 JK	**61.78 C**
CO_2 5% + O_2 5%	69.80 A	66.90 CD	62.27 F	58.54 H	56.28 I	**62.76 B**
CO_2 10%+ O_2 5%	69.80 A	62.60 F	54.40 K	53.88 K	50.23 M	**58.18 E**
Chitosan	69.80 A	65.00 E	57.00 I	56.10 IJ	52.34 L	**60.05 D**
Control	69.80 A	48.07 N	43.23 O	41.13 P	33.09 Q	**47.06 F**
mean	**69.80 A**	**63.02 B**	**57.14 C**	**54.83 D**	**51.47 E**	

Means in the same column having the same letter are not significantly different at 0.05 level by Duncan"s multiple rang test

treatment gave a slight score of 2.0 in both seasons. However, the control treatment resulted in severe discolouration with a high score of 4.33 in both seasons, in the same period.

3.5. Total chlorophyll content

Data in Table (5) revealed that there was in significant reduction in the total chlorophyll content of fresh-cut celery petioles during storage. All treatments significantly reduced the loss of total chlorophyll content as compared to control during cold storage. Fresh-cut celery petioles dipped in hot water at 45°C turned into the handiest treatment for lowering the loss of total chlorophyll content during storage followed by MAP at 5% O_2 + 5% CO_2 and hot water at 50°C treatments without a big difference among them, at the same time as the other treatments had been much less potent on this challenge. The lowest value of total chlorophyll content was obtained from the control. In preferred, the interaction between treatments and storage periods turned significant. After 16 days of storage at 0°C, data revealed that fresh-cut celery petioles dipped in hot water at 45°C or 50°C and MAP at 5% O_2 + 5% CO_2 turned into the handiest treatment for lowering the loss of the total chlorophyll content 28.0, 26.0, and 26.13 mg/100g FW (average in the two seasons respectively) with no significant differences between them compared with the other treatments, while control had the lowest value of total chlorophyll content 13.34 mg/100g FW (average in the seasons).

3.6. Total microbial count

Table 4: Effect of some postharvest treatments on discoloration (score) of fresh-cut celery during storage at 0°C in 2021 and 2022 seasons.

	After 0 day	After 4 days	after 8 days	after 12 days	after 16 days	mean
2021						
45° C	1.00 G	1.00 G	1.00 G	1.00 G	1.00 G	**1.00 C**
50° C	1.00 G	1.00 G	1.00 G	1.00 G	1.67 EF	**1.13 C**
CO_2 5% + O_2 5%	1.00 G	1.00 G	1.00 G	1.00 G	1.00 G	**1.00 C**
CO_2 10%+ O_2 5%	1.00 G	1.00 G	1.67 EF	2.33 CD	2.67 C	**1.73 B**
Chitosan	1.00 G	1.00 G	1.00 G	1.00 G	2.00 DE	**1.20 C**
Control	1.00 G	1.33 FG	2.00 DE	3.33 B	4.33 A	**2.40 A**
mean	**1.00 D**	**1.06 CD**	**1.28 C**	**1.61 B**	**2.11 A**	
2022						
45° C	1.00 D	1.00 D	1.00 D	1.00 D	1.00 D	**1.00 C**
50° C	1.00 D	1.00 D	1.00 D	1.00 D	1.67 CD	**1.13 C**
CO_2 5% + O_2 5%	1.00 D	1.00 D	1.00 D	1.00 D	1.00 D	**1.00 C**
CO_2 10%+ O_2 5%	1.00 D	1.00 D	1.33 CD	2.00 BC	2.67 B	**1.60 B**
Chitosan	1.00 D	1.00 D	1.00 D	1.00 D	2.00 BC	**1.20 C**
Control	1.00 D	1.00 D	1.33 CD	2.67 B	4.33 A	**2.07 A**
mean	**1.00 C**	**1.00 C**	**1.11 C**	**1.44 B**	**2.11 A**	

Means in the same column having the same letter are not significantly different at 0.05 level by Duncan"s multiple rang test

Data in Table (6) indicate that microbial growth in celery petioles increased significantly with increasing the storage period particularly in the untreated control.

All used treatments had lower levels of microbial load in comparison to the control treatment. Fresh-cut celery petioles treated with hot water at 45°C were the most effective in reducing microbial growth followed by hot water at 50°C and MAP at 5% O_2 + 5% CO_2 treatments with no significant differences between them, while the other treatments showed less effective in reducing microbial growth. Control had higher levels of the total microbial count.

In preferred, the interaction between treatments and storage periods turned into significant data revealed that after 16 days of storage fresh-cut celery petioles dipped in hot water at 45°C was the most effective treatment in reducing the levels of microbial load which showed the lowest counts of microorganisms and inhibition of microorganisms 3.53 log CFU/g (average in the both seasons) followed by MAP at 5% O_2 + 5% CO_2 and dipping in hot water at 50°C treatments 4.11 and 4.01 log CFU/g (average of the two seasons respectively), with significant differences between them compared with the other treatments, while control had the highest value of microbial count 7.93 log CFU/g (average of the two seasons).

3.7. Polyphenol oxidase activity (PPO)

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Table 5: Effect of some postharvest treatments on total chlorophyll (mg/100 g FW) of fresh-cut celery during storage at 0°C in 2021 and 2022 seasons.

	After 0 day	After 4 days	after 8 days	after 12 days	after 16 days	mean
2021						
45° C	36.95 A	34.11 B	31.20 C-E	29.00 E-G	27.00 G-J	**31.65 A**
50° C	36.95 A	31.23 CD	29.20 D-G	27.60 F-H	25.00 J-L	**30.00 B**
CO_2 5% + O_2 5%	36.95 A	31.60 C	29.80 C-F	28.00 F-H	25.10 I-L	**30.29 B**
CO_2 10%+ O_2 5%	36.95 A	29.00 EFG	27.20 G-J	26.00 H-K	23.00 LM	**28.43 C**
Chitosan	36.95 A	28.50 FG	27.80 F-H	25.20 I-L	23.50 LM	**28.39 C**
Control	36.95 A	27.30 G-I	24.40 KL	22.00 M	12.19 N	**24.57 D**
mean	**36.95 A**	**30.29 B**	**28.27 C**	**26.30 D**	**22.63 E**	
2022						
45° C	39.47 A	35.07 B	32.73 B-D	31.00 C-F	29.00 F-H	**33.45 A**
50° C	39.47 A	33.07 BC	31.13 C-F	30.00 E-G	27.00 H-J	**32.13 B**
CO_2 5% + O_2 5%	39.47 A	32.33 C-E	31.33 C-F	30.00 E-G	27.17 H-J	**32.06 B**
CO_2 10%+ O_2 5%	39.47 A	30.00 E-G	32.07 C-E	27.83 G-I	25.00 JK	**30.87 C**
Chitosan	39.47 A	30.33 D-G	29.83 E-G	27.00 H-J	25.00 JK	**30.33 C**
Control	39.47 A	29.00 F-H	25.67 I-K	24.00 K	14.50 L	**26.53 D**
mean	**39.47 A**	**31.63 B**	**30.46 C**	**28.31 D**	**24.61 E**	

Means in the same column having the same letter are not significantly different at 0.05 level by Duncan"s multiple rang test

Table 6: Effect of some postharvest treatments on total microbial count (CFU/g-1) of fresh-cut celery during storage at 0°C in 2021 and 2022 seasons.

	After 0 day	After 4 days	after 8 days	after 12 days	after 16 days	mean
2021						
45° C	0.12 Q	0.82 O	1.30 MN	2.50 I	3.80 F	**1.71 E**
50° C	0.26 PQ	1.04 NO	1.60 KL	3.33 G	4.10 E	**2.07 D**
CO_2 5% + O_2 5%	0.23 PQ	1.10 NO	1.80 K	2.58 I	4.40 D	**2.02 D**
CO_2 10%+ O_2 5%	0.32 PQ	1.62 KL	3.14 GH	4.22 DE	6.20 B	**3.10 B**
Chitosan	0.29 PQ	1.40 LM	3.00 H	4.00 EF	5.10 C	**2.76 C**
Control	0.42 P	2.14 J	4.22 DE	6.31 B	8.30 A	**4.28 A**
mean	**0.27 E**	**1.35 D**	**2.51 C**	**3.82 B**	**5.32 A**	
mean	**0.27 E**	**1.35 D**	**2.51 C**	**3.82 B**	**5.32 A**	
2022						
45° C	0.10 S	0.77 OP	1.17 MN	2.23 IJ	3.27 F	**1.51 E**
50° C	0.21 RS	0.68 PQ	1.48 KL	3.27 F	3.93 E	**1.92 D**
CO_2 5% + O_2 5%	0.23 RS	1.00 NO	1.57 K	2.47 HI	3.83 E	**1.82 D**
CO_2 10%+ O_2 5%	0.29 RS	1.42 K-M	2.67 GH	3.72 E	5.66 B	**2.75 B**
Chitosan	0.28 RS	1.25 L-N	2.80 G	3.90 E	4.63 D	**2.57 C**
Control	0.41 QR	2.03 J	3.94 E	5.23 C	7.57 A	**3.84 A**
mean	**0.25 E**	**1.19 D**	**2.27 C**	**3.47 B**	**4.82 A**	

Means in the same column having the same letter are not significantly different at 0.05 level by Duncan"s multiple rang test

Table 7: Effect of some postharvest treatments on PPO (Unit/min.) of fresh-cut celery during storage at 0°C in 2021 and 2022 seasons.

	After 0 day	After 4 days	after 8 days	after 12 days	after 16 days	mean
2021						
45° C	39.40 T	41.20 S	44.60 Q	50.20 L	54.30 I	**45.94 F**
50° C	39.40 T	44.82 Q	48.30 N	53.00 J	59.00 E	**48.90 D**
CO_2 5% + O_2 5%	39.40 T	43.00 R	47.20 O	52.00 K	58.00 F	**47.92 E**
CO_2 10%+ O_2 5%	39.40 T	48.30 N	53.20 J	61.00 C	64.00 B	**53.18 B**
Chitosan	39.40 T	46.40 P	49.00 M	55.00 H	60.11 D	**49.98 C**
Control	39.40 T	49.00 M	55.61 G	60.22 D	67.81 A	**54.41 A**
mean	**39.40 E**	**45.45 D**	**49.65 C**	**55.24 B**	**60.54 A**	
2022						
45° C	37.83 J-L	34.93 L	35.00 L	36.30 L	39.47 J-L	**36.71 F**
50° C	37.83 J-L	37.73 KL	43.10 H-K	46.67 E-H	52.30 C-E	**43.53 D**
CO_2 5% + O_2 5%	37.83 J-L	37.63 KL	38.47 J-L	40.57 I-L	45.77 F-I	**40.05 E**
CO_2 10%+ O_2 5%	37.83 J-L	47.14 E-H	49.14 E-G	59.80 AB	55.33 B-D	**49.85 B**
Chitosan	37.83 J-L	42.77 H-K	45.63 F-I	51.17 D-F	57.57 A-C	**46.99 C**
Control	37.83 J-L	43.83 G-J	62.10 A	59.33 AB	62.33 A	**53.09 A**
mean	**37.83 E**	**40.67 D**	**45.57 C**	**48.97 B**	**52.13 A**	

Means in the same column having the same letter are not significantly different at 0.05 level by Duncan"s multiple rang test

Table 8: Effect of some postharvest treatments on phenolic (mg/ 100g F.W) of fresh-cut celery during storage at 0°C in 2021 and 2022 seasons.

	After 0 day	After 4 days	after 8 days	after 12 days	after 16 days	mean
2021						
45° C	31.11 A	29.20 B	27.40 E	25.12 I	21.70 L	**26.91 A**
50° C	31.11 A	28.70 C	26.00 FG	23.00 JK	20.30 N	**25.82 B**
CO_2 5% + O_2 5%	31.11 A	28.20 D	26.30 F	22.70 K	20.90 M	**25.84 B**
CO_2 10%+ O_2 5%	31.11 A	27.11 E	25.60 GH	20.11 N	18.00 P	**24.39 D**
Chitosan	31.11 A	27.00 E	25.40 HI	21.50 L	19.20 O	**24.84 C**
Control	31.11 A	26.13 F	23.20 J	19.11 O	15.22 Q	**22.95 E**
mean	**31.11 A**	**27.72 B**	**25.65 C**	**21.92 D**	**19.22 E**	
2022						
45° C	29.80 A	27.20 B	25.57 C	23.50 F	20.07 H	**25.23 A**
50° C	29.80 A	27.33 B	24.50 E	21.50 G	18.30 I	**24.29 B**
CO_2 5% + O_2 5%	29.80 A	27.67 B	24.80 DE	21.73 G	18.63 I	**24.53 B**
CO_2 10%+ O_2 5%	29.80 A	25.11 CD	23.27 F	18.73 I	16.08 K	**22.60 D**
Chitosan	29.80 A	25.57 C	23.63 F	20.17 H	17.30 J	**23.29 C**
Control	29.80 A	24.24 E	21.20 G	17.33 J	13.22 L	**21.16 E**
mean	**29.80 A**	**26.19 B**	**23.83 C**	**20.49 D**	**17.27 E**	

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Data in Table (7) indicate that the PPO activity of fresh-cut celery petioles increased significantly with the prolongation of the storage period during storage. All treatments reduced the activity of PPO during storage as compared with untreated control of fresh-cut celery petioles during storage. Fresh-cut celery petioles dipped in hot water at 45°C was the most effective treatment in delaying PPO activity during storage followed by MAP at 5% O_2 + 5% CO_2 and hot water at 50°C treatments with significant differences between them. However, MAP at 5% O_2 + 10% CO_2 treatment was less effective in this concern, while, control had a higher increase in the activity of PPO enzyme during storage. In preferred, the interaction between treatments and storage periods turned significant, after 16 days of storage at 0°C data revealed that fresh-cut celery petioles dipped in hot water at 45°C was reduced PPO activity by 53.23 units/min. (average in both seasons) compared with the other treatments or control 62.12 units/min. (average in both seasons).

3.8. Total phenolic content

Data in Table (8) indicate that the total phenolic content of fresh-cut celery petioles decreased significantly with the prolongation of storage periods. Regarding the effect of postharvest treatments, data revealed that fresh-cut celery petioles dipped in hot water at 45°C turned into the handiest treatment for reducing phenolic compounds loss during storage followed by MAP at 5% O_2 + 5% CO_2 and hot water at 50°C treatments with no significant differences between them during storage. While, MAP at 5% O_2 + 10% CO_2 and chitosan coating treatments were less effective in this concern with significant differences between them.

In preferred, the interaction among treatments and storage periods turned significant, after 16 days of storage at 0°C data revealed that fresh-cut celery petioles dipped in hot water at 45°C was the most effective treatment in maintaining the phenolic content of 20.88 mg/100g FW (average in both seasons) compared with the other treatments or control 14.22 mg/100g FW (average in both seasons).

3.9. Gas composition inside the packages:

Data in Tables (9 and 10) indicated that there was a significant decrease in O_2 % and an increase in CO_2 % in the packages of celery petioles during storage. Regarding the effect of postharvest remedies on gas composition within the programs, records discovered that there have been good-sized differences between postharvest treatments and untreated management. The gas composition inside the package treated with hot water at 45°C and 50°C treatments had high O_2 levels (17.91% and 16.91% average in both seasons respectively) and low CO_2 (3.21% and 3.53% average in both seasons respectively) with significant differences between them followed by chitosan at 0.5 % treatment.

4. Discussion

The result of this study revealed that dipped fresh-cut celery petioles in hot water at 45° and 50° C and chitosan at 0.5% and active modified atmosphere packaging (MAP) at 5% O_2 + 5% CO_2 and 5% O_2 + 10% CO_2 significantly enhanced the storability and maintained the quality parameters compared to passive MAP (control). However, fresh-cut celery petioles treated with hot water at 45° and 50° C and active MAP at 5% O_2 + 5% CO_2 were the most effective in reduced weight loss, colour changes, microbial content, polyphenol oxidase activity and maintained total phenolic content and general appearance. However, samples treated with hot water at 45° C showed the best quality avoiding the loss of green colour, retarded the growth of microorganisms, not exacted any browning in the cut surface of petioles, and did not exhibit any changes in general appearance till the end of storage period (16 days of storage at 0° C), while, hot water at 50° C and active MAP at 5% O_2 + 5% CO_2 rated good appearance at the same period. This result was true in the two seasons, and similar findings were confirmed by previous studies (Gómez and Artés, 2005, Grzegorzewskaa et al., 2022 and He and Luo, 2007).

The weight loss increase during storage as a result of the increase in respiration rate, metabolic process, and water loss (Amarante et al., 2001). Similar results were reported by Viña and Chaves (2003), (2007) and Zhan et al., (2013) on fresh cut celery. The obtained results detected that hot water, MAP and chitosan treatments decreased weight loss percentage during storage. This effect might be due to hot water treatment decreasing ethylene production and causing a delay in senescence, reducing the rate of respiration, and hence a reduction in weight loss during storage (Lemoine et al. (2009) and Perini et al (2017).

MAP and polypropylene bags make a unique role in conferment the moisture around the product and

Table 9: Effect of some postharvest treatments on CO_2 % of fresh-cut celery during storage at 0°C in 2021 and 2022 seasons.

	After 0 day	After 4 days	after 8 days	after 12 days	after 16 days	mean
2021						
45° C	0.03 Q	0.60 P	1.20 NO	2.30 LM	3.30 K	**1.49 E**
50° C	0.03 Q	0.80 OP	1.30 N	2.50 L	3.60 K	**1.65 E**
CO_2 5% + O_2 5%	5.00 IJ	5.40 HI	5.90 FG	6.30 F	6.90 E	**5.90 B**
CO_2 10%+ O_2 5%	10.00 D	11.00 C	12.70 B	13.00 B	13.90 A	**12.12 A**
Chitosan	0.03 Q	1.00 N-P	3.50 K	4.83 J	5.80 GH	**3.03 D**
Control	0.03 Q	2.03 M	3.31 K	5.11 IJ	6.22 F	**3.34 C**
mean	**2.52 E**	**3.47 D**	**4.65 C**	**5.67 B**	**6.62 A**	
2022						
45° C	0.03 N	0.53 M	1.07 KL	2.10 J	3.13 I	**1.37 E**
50° C	0.03 N	0.73 LM	1.23 K	2.33 J	3.47 I	**1.56 E**
CO_2 5% + O_2 5%	5.00 GH	5.07 GH	5.37 FG	6.23 E	6.73 D	**5.68 B**
CO_2 10%+ O_2 5%	10.00 C	10.17 C	12.43 B	12.23 B	13.17 A	**11.60 A**
Chitosan	0.03 N	0.97 K-M	3.35 I	4.80 H	5.67 F	**2.96 D**
Control	0.03 N	2.01 J	3.10 I	5.10 GH	6.17 E	**3.28 C**
mean	**2.52 E**	**3.25 D**	**4.43 C**	**5.47 B**	**6.39 A**	

Means in the same column having the same letter are not significantly different at 0.05 level by Duncan"s multiple rang

Table 10: Effect of some postharvest treatments on O_2 of fresh-cut celery during storage at 0°C in 2021 and 2022 seasons.

	After 0 day	After 4 days	after 8 days	after 12 days	after 16 days	mean
2021						
45° C	20.70 A	20.00 B	19.60 C	19.00 D	18.00 F	**19.46 A**
50° C	20.70 A	19.60 C	19.00 D	18.00 F	17.00 H	**18.86 B**
CO_2 5% + O_2 5%	3.00 M	2.86 MN	2.61 NO	2.40 O-Q	2.14 QR	**2.60 E**
CO_2 10%+ O_2 5%	3.00 M	2.50 OP	2.30 P-R	2.08 RS	1.84 S	**2.34 F**
Chitosan	20.70 A	18.60 E	17.90 F	16.50 I	15.60 J	**17.86 C**
Control	20.70 A	17.30 G	15.80 J	14.00 K	12.30 L	**16.02 D**
mean	**14.80 A**	**13.48 B**	**12.87 C**	**12.00 D**	**11.15 E**	
2022						
45° C	20.70 A	19.67 B	19.40 BC	18.67 D	17.83 E	**19.25 A**
50° C	20.70 A	19.27 C	18.83 D	17.83 E	16.83 F	**18.69 B**
CO_2 5% + O_2 5%	3.00 K	2.80 K	2.43 L	2.27 LM	2.07 M	**2.51 E**
CO_2 10%+ O_2 5%	3.00 K	2.30 LM	2.10 LM	2.00 MN	1.70 N	**2.22 F**
Chitosan	20.70 A	18.50 D	17.70 E	16.27 G	15.33 H	**17.70 C**
Control	20.70 A	17.00 F	15.50 H	13.83 I	12.20 J	**15.85 D**
mean	**14.80 A**	**13.26 B**	**12.66 C**	**11.81 D**	**10.99 E**	

Means in the same column having the same letter are not significantly different at 0.05 level by Duncan"s multiple rang

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therefore lowest weight loss. This increases the relative humidity and reduces vapour pressure deficit and transpiration. On the other hand, polypropylene bags create a MAP with reduced oxygen and increase carbon dioxide concentration around the product which decreases the weight loss percentage by slowing down the metabolic processed and transpiration (Gómez and Artés, 2005).

Low weight loss and maintained quality and storability from chitosan treatment are due to a semipermeable film on the surface of celery petioles that can be formed by the chitosan, consequently modifying the internal atmosphere of the petioles with limited gas exchanges due to the coating barriers, enzymatic activity and metabolism in evolving respiration (Raymond et al., 2012).

The general appearance of celery petioles decreased during storage periods and this may be due to shrivelling, wilting, colour changes, and decay (Velickova et al., 2013). The preservation of the general appearance of celery treated with hot water, MAP, and chitosan may be due to, hot water, Loaiza-Velarde and Saltveit (2001) found that hot water was effectively acting as antioxidants enzymes of celery and this could reduce the deterioration, physiological disorders and enhance the resistance of tissue against microbial growth and reduce the spoilage of product (Loaiza-Velarde and Saltveit, 2001).

Akbudak (2008) found that MAP´s slower physiological processes in celery and lower incidence of spoilage in this celery may be explained by the retention of celery quality through MAP in terms of water loss. Velickova et al. (2013) stated that chitosan coating acts as a semipermeable barrier at the surface of fruit and vegetables against oxygen, carbon dioxide, and moisture, thereby reducing respiratory, water loss, respiration pastime and degradation via enzymes and microbial rot of fruits, counteracting the dehydration and shrinkage of the fruit, and ethylene manufacturing and keeping the generally great and prolongation the shelf existence.

Colour is one of the main visual quality criteria that influence whether or not consumers would accept fresh products. To assess the colour change that happens in the product across all storage periods. The colour parameter L value (Lightness) was measured. The L value represented the visual appearance of the product by indicating the brightness or darkness of the celery surface (Gómez and Artés, 2005). With increasing storage period, the L value of celery declined dramatically and a slight yellowness occurred on the surface of the celery. A reduction in the L value indicated that the surface is darkening (Velickova et al., 2013). Ardiakani and Mostofi (2019) showed that decreasing L value is related to water loss of products.

The results showed that all postharvest treatments had significantly higher L values compared with the control. That result is in agreement with Saltveit and Mangrich (1996) and Gómez and Artés (2005).
The faster increase in the yellow colour of celery p

etioles in passive MAP is due to excess O_2 that causes enzymatic browning (Loaiza-Velarde et al. (2003) and Kobayashi et al. (2021). Celli et al. (2018), Xing et al. (2011), and Xing et al. (2019) reported that chitosan-coated slightly lightened as evidenced by an increase in L value.

The obtained result indicated that there is an increase in discolouration (score) of the celery petioles with the extension of the storage period. These results are in agreement with Gómez and Artés (2005). The change in colour development is related primarily to the oxidation of phenolic compounds to o-quinone a reaction catalysed by PPO. Quinone is polymerized into dark brown, black or red polymers (Saleh et al., 2013).

The reduction of discolouration on the cut surface of celery petioles treated with hot water or MAP may be due to those treatments reducing PPO and preserving the total phenolic content. So, this treatment makes a reduction of colour change in the cut surface (Loaiza-Velarde et al. (2003) for hot water and Gómez and Artés (2005) and Kobayashi et al. (2021) for MAP on fresh-cut celery petioles).

Furthermore, the total chlorophyll content of celery petioles decreases with increasing storage period, this may be due to a gradual increase in the degradation of chlorophyll and the conversion of chloroplasts in to chromoplasts caused by the activity of the chlorophylase (He and Luo, 2007). Those outcomes are in settlement Kader (1986), Velickova et al. (2013) and Qi et al. (2011) for hot water and Gómez and Artés (2005) for MAP and Xing et al. (2011) and Xing et al. (2019) for chitosan.

The reduction in chlorophyll loss during storage in the celery petioles treated with hot water, MAP, and chitosan treatments might be due to the effect of these treatments on the physiological processes involved in the degradation of chlorophyll (decreased activity of chlorophyllase and consequence reduced colour change (Loaiza-Velarde et al. (2003) on celery petioles).

Also, Loaiza-Velarde et al. (2003) and Gómez and Artés (2005) reported that celery petioles stored at MAP reduce the breakdown of chlorophyll to phaeophytin during storage.

The obtained results showed that hot water, MAP and chitosan treatments had lower levels of microbial load in comparison to control. These results are in agreement with Chan et al. (1989) for hot water, Nielsen and Leufven (2008) for MAP and Fang et al. (1994) for chitosan. The previous results have demonstrated that celery petioles stored at active MAP (6% O_2 + 7% CO_2) reduced mesophilic and psychrotrophic growth during storage. Also, the active MAP apparently behind-schedule fruit senescence and inhibited microbial increase, and controlled the exponential boom of microbial microorganisms (Nielsen and Leufven, 2008).

Dipping the samples in hot water led to some decrease in fungal development may be associated with the washing off of a number of natural pathogenic spore populace from the surface of the fruits. However, one of these dip may additionally get rid of a part of the herbal opposed flowers inhibiting the fruit peel which may act as a bio manage agent of postharvest pathogens (Chan et al. (1989) on cucumber). Farber (1991) found that CO_2 inhibits microbial hobby in two methods, it dissolves in water in the product, and it has a poor impact on enzymatic and biochemical sports in cells of each product and microorganisms.

The antimicrobial of chitosan is probably caused by the interaction between chitosan and the microbial cell membranes, which leads to the leakage of proteinaceous and other intracellular constituents. Chitosan can penetrate the nuclei of fungi cell and interferes with RNA and protein synthesis (Rabean et al., 2003). Also, this was probably due to the fungicidal action of chitosan that caused alteration in the function of the cellular membrane of fungal cells (Fang et al., 1994).

Chitosan has the ability to resist several fungi and induce defence enzymes such as chitinase and chitosanase, which are associated with induced systemic resistance of fruits (Irkin et al., 2014).

The obtained results showed that the polyphenol oxidase (PPO) activity of fresh-cut celery increased with the prolongation of the storage period during storage. The increase of PPO activity in celery petioles after slicing is in particular because of the activation technique from latent to absolutely lively form. In fact, as previously stated by Cantos et al. (2001) tissue wounding includes the decompart metallization of cellular additives with the following launch of proteases related to a cascade of reactions main to the activation of latent PPO.

The reduction of PPO activity of fresh cut of celery treated with hot water, MAP, and chitosan may be due to these treatments, reduced respiration rate and which provides a decrease in metabolic activities and suppresses the enzyme activities during storage Loaiza-Velarde et al. (2003) for hot water and Gómez and Artés (2005) for MAP and Qi et al. (2011) for chitosan.

Hot water treatment reduced enzymes activities (PPO, PG, and Cellulase) and enzymes related ripening of fruit (Viña and Chaves, 2007). Active MAP reduces enzyme activity due to a decrease in O_2 and an increase in CO_2 concentration in the headspace surrounding the product (Gómez and Artés, 2005).

The inhibitory effect of chitosan remedy on PPO interest might be due to a low O_2 availability in the sweet cherry fruit (Qi et al., 2011). The reduction in skin and flesh shade adjustments is because of the upkeep of cell compartmentalization and separation of PPO and POD enzymes from their phenolic substrates. Similarly inhibited POD and PPO sports had been found in response to opportunity technology to chitosan coating hired on unique fruit to enhance

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their postharvest shelf life (Zhang et al., 2015).
Phenolic compounds are responsible for most of the antioxidant activity in products making them a natural source of antioxidants (He and Luo, 2007). The decrease in total phenolic content with the prolongation of storage periods may be due to phenolic compounds having a significant role in oxidation processes as antioxidants and as substrates in browning reactions. During storage, the enzymatic oxidation is continued and the resulting quinones are polymerized non-enzymatically to give darker pigments, which explain the parallel consumption of phenols with the development of blackness throughout the storage period (Robards et al., 1999).

All postharvest treatments reduced the loss of total phenolic content compared with control during storage. These results were in agreement with He and Luo (2007) and Loaiza-Velarde et al. (2003) for hot water and MAP and Jongsri et al. (2016) for chitosan.

MAP maintained higher total phenolic content because of the reduction of processes. MAP with low O_2 and high CO_2 was the most effective for retaining total antioxidant activity and total phenolic throughout the storage period (Grzegorzewskaa et al. (2022) in hot water).
Chitosan has been reported to increase the potential of the reactive oxygen species scavengers, leading to increased contents of phenolic compounds and antioxidants (Jongsri et al., 2016). Also, treatment with different concentrations of chitosan has also been reported to activate the antioxidant enzymes catalase (CAT), superoxide dismutase (SOD), and peroxidase (POD), which are an important part of the antioxidant potential during storage, in tomatoes (Liu et al., 2007) and guava (Hong et al., 2012).

Increasing the CO_2 concentration around the product may be promoting the synthesis and accumulation of phenolic as a physiological reaction. CO_2 storage had marked effects on phenolic metabolites while MAP had a nice effect on phenolic-associated quality (Tomás-Barberán and Espin, 2003). High CO2 may also allow for the removal of free radicals, which might be related to preserving antioxidant capability (Wang et al., 2003).
The obtained results indicated that there was a significant decrease in O_2% and an increase in CO_2% in the package of celery petioles during storage. Similar results were obtained by Viña and Chaves (2003) and Cantwell and Suslow (2002) on fresh-cut celery. They may be due to O_2 consumption and CO_2 production of fruits during the respiration process (Ubhi et al., 2014). The high O_2% and low CO_2% inside the packages of MAP, chitosan, and hot water may be due to reduced and decrease respiration rate and consequently reduced consumption of O_2 and accumulation of CO_2 levels inside the bags (Gómez and Artés (2005) on MAP, Jongsri et al. (2016) for chitosan, and Kobayashi et al. (2021) for hot water).

5.Conclusion

Fresh-cut celery petioles dipped in hot water at 45º C for one min. showed the best quality avoided the loss of green colour, retarded the growth of microorganisms, not exacted any browning in the cut surface of petioles, and did not exhibit any changes in general appearance.

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, analysis, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

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Traditional Seafood Product Purchase Through E-commerce: The Impact of Perceived Risk and Benefit to Consumers' Intention to Buy

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Traditional seafood products in Indonesia are diverse, influenced by ethnicity and eating habits. However, the problem is the low level of consumption of seafood products in Indonesia. A limited number of traditional seafood products have entered e-commerce due to the need for more knowledge about consumer demand. In order to boost the purchase of traditional seafood products, consumers' perception needs to be explored as it plays a prominent role in a successful food product. The aim of this research is to analyse the impact of perceived risks and benefits on the purchase intention of consuming traditional processed seafood on e-commerce. Data were collected by using an online questionnaire with the number of respondents of 246 participants. This research results showed that security risk is the perceived risk factor that significantly influences the intention to buy seafood products on e-commerce. Another finding, consumers consider the product's benefit as a significant factor in buying traditional seafood on e-commerce. This paper provides novel insight into the body of knowledge about consumer perception of the risk and benefits of purchasing seafood through the online market, specifically related to product characteristics and benefits, as well as new sales methods.

1. Introduction

The utilization of digital technology has been escalating in the last decade as it permeates into broader parts of the community and economy. Electronic-based commerce (e-commerce), one of the most significant sectors in the digital economy, primarily accelerates value growth among digital users. Due to the pandemic, more people have shifted their purchasing methods from shopping in a retailer or mall to online buying. According to a survey report (DBS Bank, 2020), the Gross Marketing Value (GMV) of Indonesia's e-commerce surged to US$10 billion at the end of 2020. It showed that even though Covid-19 has negatively impacted the overall economic condition in Indonesia, e-commerce could be a potential sector for recovery. Moreover, e-commerce has become a booming trend for consumers buying food in Indonesia because of its convenience (Nugraha et al., 2019) and the one-stop shopping experience (Utami et al., 2019). Based on a survey from Indonesian e-commerce, food is the third most popular product category to be sought by customers (Wihardja & Ali, 2021), so selling food products via e-commerce is one of the most potent ways to reach broader market segments.

Indonesia is one of the largest seafood producers in the world due to its location in fish-rich waters and its long fishing tradition. On the other side, seafood consumption in Indonesia is still low. Indonesia's fish consumption rate is relatively lower than the other ASEAN countries (Yee et al., 2017). In addition, the level of consumption is not evenly distributed among regions in Indonesia, as indicated by the fish consumption rate on Java island is much lower than the other islands, even though it has the highest population density (Arthatiani et al., 2018). This low level of fish consumption can be increased by introducing seafood products on e-commerce which can reach a wider range of consumers. Thus, this research is expected to be the basis for determining the strategies of entrepreneurs and the government to improve consumers' intention to buy seafood.

Previous studies have outlined the concept of perceived risk and health benefit separately in their impact on purchasing decisions. Based on the literature study, a limited journal specifically investigates the perceived risk of purchasing seafood through online platforms because it may be affected by multiple factors, from the intrinsic quality of seafood products to the distribution channel, and virtual transactions.

Temesi et al., (2020) explored perceived risks that hinder fish consumption in a low-fish-consumption country, including psychological, physical, social, and functional risks. In another case, perceived risk is one of the factors influencing purchase intention during the Covid-19 outbreak (Hing & Vui, 2021). Nonetheless, this research does not identify specifically each type of risk arising from quality evaluation by customers, the impact of different supply chains, and financial factors. Additionally, the benefits also have been published as the main functional factor for consuming seafood (Sirot et al., 2012)(Uchida et al., 2017)(Jacobs et al., 2018). Those publications focus on balancing the health risk and benefits of seafood consumption. Therefore, this paper has filled the gap regarding the identification of various risks and their interaction with the benefits of traditional seafood in shaping consumer behaviour. The aim of this research is to analyse the impact of perceived risks and benefit factors on to purchase intention of consuming traditional processed seafood on e-commerce. The following research question (RQ) for this study:
RQ. What is the influence of perceived risk and how does it benefit the consumers' intention to buy traditional seafood on e-commerce?

Wang et al., (2020) used several innovation-adoption characteristics that influence consumers' adoption of online food shopping (perceived social norm, perceived incentive, perceived complexity, and perceived relative advantage). Perceived social norm (PSN) refers to the perceived opinions of other people on an individual adoption of online food shopping, and it is positively linked to purchase intentions for online food shopping. Perceived complexity (PCL) is the degree of the usage complexity of online food shopping perceived by consumers, and it is negatively linked to the purchase intentions for online food shopping. It is in line with the research of Ardyanto & Riyadi, (2015) that the ease of using e-commerce influenced online purchasing decisions. Perceived relative advantage (PRA) is the perceived degree of the superiority of online food shopping compared to existing offline food shopping. Previous studies indicated that consumers perceived two main advantages of online food shopping compared to traditional offline shopping: purchase convenience (e.g., time-saving) and price advantage (e.g., money-saving), which positively influence consumers' attitudes, purchase intentions, or consumptions for online food shopping (Anesbury et al., 2016).

Perceived risk plays a significant part in determining consumer purchase intentions. Perceived risk relates to the degree of uncertainty and potentially negative consequences for the consumer from the online transaction (Kim et al., 2008). Ariffin et al., (2018) examined the relationship between five types of perceived risk and online purchase intention. Consumers will have a positive online shopping experience if consumers have lesser perceived risk levels on the internet. Han & Kim, (2017) examined a multi-dimensional perceived risk which includes financial, privacy, product, security, social, and time. In order to make a concise set of variables, some parameters were eliminated based on the closeness of the measurement point, such as the time-risk dimension being merged into the PRA variable and the social-risk dimension being merged into the PSN. Several researchers focused on the effect of

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financial risk (FR) in online shopping. The result from Guru et al., (2020) stated that FR is one of the top-ranked considered by online consumers. FR includes consumers' concern about the possibility of monetary loss or wasting money (Rosillo-Díaz et al., 2020) and trusted sellers (Wang et al., 2020b). Besides FR, security risk (SR) plays a vital role in consumer intention due to the massive growth of the internet globally(Ariffin et al., 2018). SR is related to inadequate internet security of consumers' financial information (bank account and credit card number) and personal information, such as delivery address (Ariffin et al., 2018).

The product risk (PR) variable is used to measure the risk that arises because consumers cannot directly assess the product. Zhang (2016) and Charlebois et al. (2021) stated that one of the following problems for fresh food on e-commerce is the loss of user experience with the product. Online selling is different from conventional ones, where consumers can judge the products by smelling, holding, or even tasting the product sample to check the quality of the food. Ariffin et al., (2018) used product risk as one of the variables to predict consumer's online purchase intention. Several physical dangers associated with fish eating include choking on bones, allergic responses, spoiled fish, and pollutants such as heavy metals (Temesi et al., 2020).

Besides those various risks, It is commonly acknowledged that seafood plays a significant role in a healthy diet. According to several studies, most people are aware of the potential benefits of seafood for their health and nutritional status (Jacobs et al., 2015). The factor of perceived health benefit (B) is also utilized by (Minnens et al., 2020) to explore how health benefit is perceived by seafood consumers. In this research, the factors of health benefits were explored in a preliminary interview with respondents and also based on previous studies. Table 1 is a summary of the theoretical model formation.

This study attempts to contribute to understanding perceived risk related explicitly to seafood purchases from e-commerce. Previous studies only focused on the risks impacted by online transactions and seafood as a consumer product purchased from the conventional market. Second, this paper integrates several theoretical approaches, various risks, and benefits of food online purchase, and intrinsic material of seafood such as contamination and functional aspects, to build a new consumer behaviour model. Last, the policy implication expected from this study is about the government's strategy to expand the market share of traditional seafood producers through online business training and proper production technique that can minimize risks.

Table 1. Summary of Model Formulation

No.	Variables	Relation to I (Intention to buy)	Reference
1	Perceived Social Norm (PSN)	positive	Wang et al., (2020)
2	Perceived Complexity (PCL)	negative	Wang et al., (2020)
3	Perceived Relative Advantage (PRA)	positive	Wang et al., (2020)
4	Financial Risk (FR)	negative	Rosillo-Díaz et al., (2020)
5	Product Risk (PR)	negative	Ariffin et al., (2018)
6	Security Risk (SR)	negative	Ariffin et al., (2018)
7	Product Risk of Seafood (PRI)	negative	Temesi et al., (2020), preliminary research
8	Perceived Health Benefit (B)	positive	Minnens et al., (2020), preliminary research

2. Materials and Methods

2.1 Data Source and measurement scale

Before the main survey began, the preliminary questionnaire was carried out by using CATA (Check-All-That-Apply) question to collect information quickly from respondents regarding the perceived risks and benefits of purchasing seafood products through e-commerce. One of the advantages of CATA questions is respondents can choose the response alternatives from a list without constraint on the number of responses (Kunz & Fuchs, 2018). The respondents for this survey were 42 respondents.

An online questionnaire is used to gather empirical data to assess the study's proposed hypotheses. There were three sections: (1) demographic data, (2) perceived risk and benefit factors, and (3) consumer response about buying traditional processed seafood on e-commerce. For the first section, demographic parameters are filled by choosing a category based on respondent condition. There are five variables in the second section and three variables in the third (see Table A1). The second and third segments are intended to evaluate the conceptual model. A five-point Likert scale is used in this section because it provides more accurate measures and respondents are more likely to think carefully about their answers with fewer choices. Based on Joshi et al., (2015), understanding all items and points on a scale requires a judgment time and a memory span. The questionnaire's items are modified from earlier studies published in the literature.

2.2 Data Collection Procedure

Collecting data begins with distributing an online questionnaire. The requirements to become respondents for the online questionnaire are 17 years old and have used e-commerce to buy food products. The requirement of age is based on the regulation for the legal user of e-commerce, while the second requirement is selected due to research interests to determine consumer perceptions based on their experience buying food products through e-commerce. Additionally, data collection was taken on August 2022 – September 2022 by utilizing an online questionnaire through Google Form survey software. The benefit of using Google Forms is the ability to distribute questions to a large number of respondents. Similarly, the form is editable, so the survey maker or researcher is able to revise the questions anytime. There are some procedures to collect data, such as constructing questions to represent the research and distributing the questionnaire to the targeted group via WhatsApp, E-mail, and Telegram. After data was collected with the expected number of respondents, validity and reliability analysis was conducted, and proceed to statistical analysis.

2.3 Statistical Analysis

AMOS 22 is used to process a confirmatory factor analysis (CFA) to inspect the correlation among independent and dependent variables, as well as the convergent validity and discriminant validity tests to check the validity of the construct to ensure model adaptability.

3. Results

3.1 Evaluation of Measurement Model

- Convergent and Discriminant Validity

Convergent validity measures how well a constructed variable represents its latent variables, using the loading factor value for each construct. The validity criteria of the loading factor value are> 0.60. Based on the result of the convergent validity test in AMOS 22, invalid indicators must be removed from the model with a loading factor value of <0.6, namely FR3 and PR 1. After removing these indicators, the loading factor values for all indicators are > 0.6, indicating that they can be claimed as valid constructs.
Furthermore, discriminant validity measures the correlation between indicators and the latent variables by empirical standards, based on the value of cross-loading. The result of each indicator has a more excellent loading value than other latent variables. It means that each indicator highly correlates with the latent variable to be measured.

- Reliability Test

The reliability test used in this model is composite reliability. The composite reliability test results show that all variables have values >0,7. Therefore, all variables are reliable.

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3.2 Evaluation of Structural Model

The structural model evaluation uses the R-square value with the result of 0.605. This value fulfilled the rule of thumb value < 3.0 and showed an acceptable fit between the collected sample data and a hypothetical model. (Kline, 2011).

3.3 Hypothesis Testing Result

The hypotheses testing result for this research is measured by Estimate, Standard Errors (S.E.), Critical Ratios (C.R.), and P-Value (P), where acceptance or rejection of hypotheses is determined by the P-value (Filho et al., 2013). The criteria of significant relation are P-Value <0.05. The results of hypothesis testing can be seen in Table 2. Based on the table, the variables having a significant influence on I are perceived benefit (B), perceived social norm (PSN), and security risk (SR).

4. Discussion

The results of the confirmatory factor analysis (CFA) presented in the study suggest that several factors that were previously expected to influence consumers in buying seafood products through e-commerce platforms are not significant. These factors include (1) financial risk, (2) perceived complexity, (3) product risk, (4) perceived relative advantage, and (5) product risk of seafood.

The finding that financial risk is not a significant factor in influencing consumers' decision to purchase seafood products online may be surprising, as previous studies have identified financial risk as a major concern for online shoppers (Ariffin et al., 2018)(Guru et al., 2020). Financial risk refers to the risk of losing money due to overbudgeting or impulsive buying, or the risk of financial information being compromised (Rosillo-Díaz et al., 2020). One possible explanation for the insignificant influence of financial risk in this study could be the sample characteristics. The study may have included consumers who are more confident in their ability to navigate e-commerce platforms and make secure financial transactions online. Almost all respondents (246 out of 247) have a higher educational background, ranging from senior high school to undergraduate or graduate degrees. This finding is also supported by a report about the Indonesian Growth of E-commerce Users in 2020. The report stated that Indonesian consumers are becoming more confident in their ability to navigate e-commerce platforms and make secure financial transactions online (Google & Temasek, 2020).

Similarly, the insignificant influence of perceived complexity may be attributed to the growing ease of use of e-commerce platforms. As online shopping becomes more mainstream, consumers are becoming more familiar with the process and may no longer perceive it as complex or difficult. According to a report (Google & Temasek, 2020), the number of online shoppers in

Table 2. Hypothesis Testing Result

Hypotheses				P Values	Decision
H1.	B	-->	I	0.000	**Accepted**
H2.	FR	-->	I	0.681	Rejected
H3.	PCL	-->	I	0.835	Rejected
H4.	PR	-->	I	0.612	Rejected
H5.	PRA	-->	I	0.870	Rejected
H6.	PRI	-->	I	0.280	Rejected
H7.	PSN	-->	I	0.000	**Accepted**
H8.	SR	-->	I	0.041	**Accepted**

Indonesia reached 92 million in 2020. This represents a 12% increase from the previous year. This indicates a significant shift in consumer behaviour towards online shopping. Furthermore, the Indonesian government has also taken steps to promote e-commerce and digitalization in the country. In 2020, the government launched the "Making Indonesia 4.0" program, which aims to encourage the adoption of digital technologies and e-commerce among Indonesian businesses and consumers (Ministry of Industry and Trade, 2021).

The study found that product risk has an insignificant influence on consumers' e-commerce purchasing behaviour. The questionnaire elaborated on the types of perceived product risk when purchasing food products on e-commerce, such as (1) the absence of the ability to directly touch or taste the food product, (2) concerns about receiving food products of lower quality than expected, and (3) inaccurate product descriptions. These factors may not be significant due to the level of consumers' trust, which is impacted by the reputation of the platforms, as well as ratings and reviews from other customers (Ullal et al., 2021). Therefore, it is possible that different aspects of product risk could have varying degrees of influence on consumers' e-commerce purchasing behaviour.

Perceived relative advantage is another factor that was found to be insignificant in the CFA. One possible explanation for the insignificant influence of perceived relative advantage in this study could be that the advantages of buying food products online are not clear to the respondents. The items for this factor consist of time-saving and greater price discounts of buying food products through e-commerce compared to conventional purchase, which could overlap with the measurement of other questionnaire items about benefit factors of seafood purchase from online shopping. These benefits include high nutritional value, unique taste, halal status, affordable price, and ease of processing.

As a result, the perceived social norm positively impacts consumers' intention to buy traditional seafood products on e-commerce. The influence of consumers on online purchases comes from their family members and closest friend. They also perceived that, based on their social references, buying food products is an excellent way to live. This result is in line with former studies on online shopping (Çelik, 2011)(Srinivasan, 2015). Related to online shopping, consumers believe that their friends and relatives can strengthen their openness and online engagement. Therefore this belief contributes to shaping their behaviour in purchasing products through e-commerce (Aldhmour & Sarayrah, 2016).

Security risk is also a significant factor influencing consumers to buy seafood products through e-commerce. The previous studies also resulted in a significant relationship between security risk and online purchases (Thakur & Srivastava, 2015)(Ariffin et al., 2018). In this research, even though consumers are worried about the security factor in e-commerce transactions, this positively impacts their interest in shopping. This phenomenon can occur because of an increase in the performance of e-commerce which can guarantee customer data security.

The most substantial impact of buying traditional seafood products in e-commerce is from benefit factors. From this finding, traditional seafood products' intrinsic quality and functionality can influence consumers to buy seafood products on e-commerce. Thus, the outcome of the study recommends that online businesses strongly consider product quality and maximize their promotion to highlight the benefits of their product on online platforms. The further strategy to provide critical aspects of seafood products on e-commerce has been studied by Taka, (2022) by using a text mining approach. The tool is useful for analysing unstructured data and identifying key themes and patterns. It allows researchers to gain insights into customer perceptions and preferences, which can be used to improve product design, marketing strategies, and customer satisfaction with seafood products on e-commerce.

5. Conclusion

The study intended to measure perceived risk factors influencing consumers to buy traditional seafood products on e-commerce. The result of this study shows that among the several risks proposed in the model, only financial risk significantly influences consumer behaviour. In addition, other factors that influence consumer purchases of traditional seafood products are social norms and perceived benefits. The

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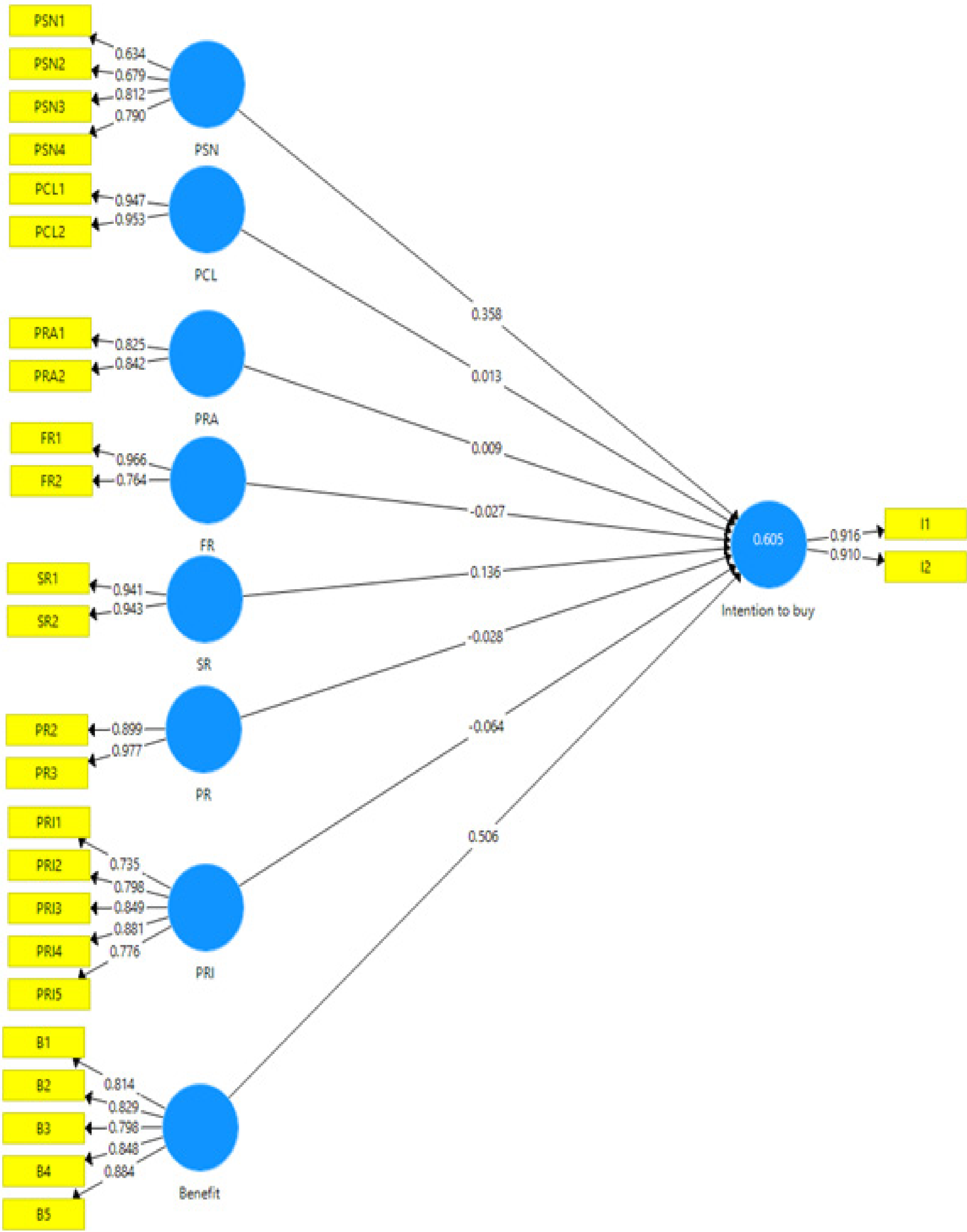

Figure 1. The Result Model of Confirmatory Factor Analysis

study has some limitations regarding predictive model formulation due to the absence of respondents' experience with traditional seafood purchases. Furthermore, the study has yet to consider online shopping in the specific context of traditional seafood e.g. smoked tuna.

The research findings have theoretical implications for the understanding of consumer behaviour in the context of seafood purchases on e-commerce. The significant influence of security risk on the intention to buy seafood products online highlights the importance of trust and security in the e-commerce environment. Furthermore, the finding that consumers consider product benefits as a significant factor in buying traditional seafood on e-commerce highlights the importance of understanding consumers' attitudes towards product characteristics when it comes to seafood purchases online.

The first practical implication of the results is that e-commerce platforms and seafood retailers should prioritize the security measures of their online transactions to reduce consumers' perceived security risks and increase their intention to buy seafood products online. Second, e-commerce platforms should focus on providing clear and accurate information about the benefits of seafood products, such as nutritional value, taste, and freshness, to attract and retain customers.

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

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Analysis of Food Consumption Patterns as a Step for Mapping Future Food Needs Based on the Potential of Local Food

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Keywords

Food consumption pattern; local food; future food

Muara Gembong Village, in Bekasi Regency, West Java is an area that has a variety of potential local food ingredients that can improve the welfare of the surrounding community. It is necessary to map the consumption and use of local food ingredients in the area so that it can be identified as the type of food that needs to be developed as a strategy to improve food security in Muara Gembong village. One way to identify this is by analysing the community's food consumption patterns. This study aims to analyse food consumption patterns as a step-in mapping future food needs based on local food potential in households in Muara Gembong village. The method used is descriptive quantitative with respondents in the form of household members consisting of father, mother, and children with a range of age from 17 years to 60 years. The data collection technique used was using a questionnaire distributed to 100 respondents. The results of this study stated that the types of foodstuffs with a high level of consumption were white rice, shallots, chilies, bananas, papaya, beef meatballs, chicken meatballs, and tilapia fish. The results of the mapping show that the food consumption patterns of the people in Muara Gembong village are still relatively less varied and centered on one type of food in each group, so it is necessary to use other food ingredients as an effort to diversify, especially local food that has the potential as food for the future.

1. Introduction

Government Regulation of the Republic of Indonesia (2015) concerning Food Security and Nutrition explains that food security is a condition in which the state is fulfilled until Based on food the availability of sufficient food, both in quantity and quality, is safe, diverse, nutritious, equitable and affordable and does not conflict with religion, belief, and community culture to be able to live a healthy, active and productive life in a sustainable manner (Pemerintah Republik Indonesia, 2015). In 2021, Ketaren noted that Indonesia was placed second in the world as the Largest biological wealth in food produces such as Vegetables, Fruits, Herbs, and Spices (Ketaren, 2021). This wealth is also supported by the diversity of tribes that spread from Sabang to Merauke which opens 1,335 tribes (Ketaren, 2021). These two things create diversity in the use of food ingredients, processing methods, and presentation methods, to the eating habits of each region in Indonesia. Seeing the potential that Indonesia has based on the wealth and diversity of these foodstuffs, Indonesia should have strong, self-reliant food security.

Food security is very important and strategic because food is a basic human need. Food security in an area can be measured by the availability of food, purchasing power, and the level of population consumption (Kementerian Pertanian Republik Indonesia, 2021).

Indonesia's potential and natural wealth as described previously is not directly proportional to food security in several regions. There are 66 districts that are included in the food insecurity category out of a total of 416 districts based on the results of the Food Security and Vulnerability Atlas (FSVA) analysis or the 2020 Food Security and Vulnerability Map. The mapping is carried out based on nine indicators covering three dimensions of food security, namely food availability, consumption food, and food affordability. Based on a survey by the Food Security Service (DKP) of Bekasi Regency in 2017, Muara Gembong District is included in one of seven villages in five sub-districts in Bekasi Regency which are classified as food insecure areas.

The condition of food security in Bekasi Regency is slowly improving. This can be seen from the Food Security Index (IKP) of Bekasi district in 2021 which scored 86.29 and was ranked 15th out of a total of 416 districts recorded (Food Security Agency, 2021). The Indonesian Food Security Index report on Bekasi District shows that food security has increased, but this value can certainly increase considering the potential of natural resources that exist in areas in Bekasi District. Muara Gembong District has abundant local food potential because its area is on the coast with areas of beaches, rivers, and open ponds (Saribanon et al, 2017). Therefore, it is necessary to determine a strategy to increase food security in accordance with the conditions and situations of the region and the local people.

The pattern of food consumption is the composition of the type, quantity, and frequency of food consumed by a person or group of people at a certain time interval (Baliwati et al, 2010). Food consumption patterns will be formed and influenced by the availability of food in an area as well as eating habits that are passed on from one generation to the next. Food consumption is one of the main drivers of environmental change because on the one hand food is a basic human need but on the other hand this need can pose a critical threat and impact on the environment (Notarnicola et al, 2017). The pattern of food consumption is also an illustration of the eating habits of the surrounding community and the types of commodities that are consumed the most. Food consumption patterns can also be used to determine the level of energy adequacy for individuals by analysing the frequency and amount of food each individual eats in one day. Based on this, the community's food consumption pattern can affect the quality and nutritional status of the surrounding community.

One of the solutions to tackling the environmental impacts caused by human food consumption patterns is to diversify the consumption of foodstuffs that have the potential as future food. Food of the future is food that has more nutrition for the body, and less negative impact on the environment. The introduction and habituation of the consumption of future types of food is important to do so that people can start to get used to consuming local food ingredients that have the potential to future food ingredients.

Mapping food consumption patterns in the Muara Gembong village community, especially in the family or household scope, is something that needs to be done so that there is data related to the type and frequency of consumption of certain foodstuffs. Based on these data, the frequency of consumption of local food-based future types of food can be verified. This mapping can also help reduce nutritional problems in an area connected to food availability, people's purchasing power, and the ability to gain access to nutritious food (Predi, 2013). This study aims to analyse food consumption patterns as a step for mapping future food needs, based on local food potential in households in Muara Gembong village.

2. Material and Methods

The method used in this research is a survey of food consumption patterns which will then be tabulated, and a future food mapping based on local food ingredients at home in Muara Gembong village will be carried out. The data collection technique used was a questionnaire distributed to 100 respondents who were residents of Muara Gembong village. This research was conducted in Pantai Mekar Village, Muara Gembong District, Bekasi Regency, West Java. The

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subjects of this study were household members consisting of fathers, mothers, and children with an age range of 17 years to 60 years. The results of filling out the questionnaire are then processed and presented descriptively in the form of tables or diagrams to make it easier to see the food consumption patterns of the people in Muara Gembong village.

3. Result & Discussion

The mapping of the food consumption pattern of the Muara Gembong village community was carried out by grouping several types of food into seven groups namely, cereals and processed products thereof; tubers; vegetables; fruits; land animals and processed products; fowl, flying animals, and their processed products; as well as water animals. The following are the results of the analysis and mapping of food consumption patterns based on local food ingredients with the potential as future food.

The mapping of the food consumption pattern of the Muara Gembong village community was carried out by grouping several types of food into seven groups namely, cereals and processed products thereof; tubers; vegetables; fruits; land animals and processed products; fowl, flying animals, and their processed products; as well as water animals. The following are the results of the analysis and mapping of food consumption patterns based on local food ingredients with the potential as future food.

3.1 Cereals and Their Processed Products

White rice is a type of food from the cereals and their processed products with the highest consumption rate of 98%, while brown rice, black rice, and black glutinous rice are types of food with the lowest consumption rate of 0% with a frequency of more than seven times a week. In 2020 the household rice consumption rate for West Java province will reach 97.26 kg per capita per year (Ministry of Agriculture, 2021).

Rice is the staple food of the Indonesian people and is a type of cereal with a high level of consumption. As a source of carbohydrates and staple food, rice can be replaced with various other types of cereals or even root products such as cassava, taro, canna, and other types of tubers.

Table 1. Mapping Results of Cereal Consumption Patterns and Processed Products

Foodstuff	Never	Once a week	a week 2-3 times	a week 4-6 times	a week 7 times	a week > 7 times a week	Amount
White Rice	0	0	1	0	1	98	100
Brown rice	94	6	0	0	0	0	100
Black Rice	98	2	0	0	0	0	100
White Glutinous Rice	87	7	5	0	0	1	100
Black Glutinous Rice	89	8	3	0	0	0	100
Corn	78	7	9	5	1	0	100
Rice noodles	28	21	14	7	3	27	100
Kwetiau	52	16	14	6	1	11	100
Flour	22	13	21	10	5	29	100
Bread	30	16	11	14	5	24	100
Wet noodle	46	19	15	6	1	13	100
Dry noodle	0	15	14	5	1	11	100
Instant noodles	9	24	26	17	5	19	100
Soybeans	51	16	17	4	3	9	100
Peanuts	36	27	10	8	6	13	100
Mung beans	44	24	14	8	1	9	100

3.2 Tubers

For the tubers group, cassava is the food ingredient with the highest consumption rate of 11% and tapioca has the lowest consumption rate of 2% with a frequency of more than seven times a week. Cassava or also known as cassava is one type of tuber with characteristics that are close to wheat flour but have lower calories than wheat flour (Ariani et al, 2016). The Indonesian people themselves make cassava as a staple food as well as a raw material for making cakes and snacks with either savoury or sweet flavours. Cassava is one of the local food ingredients in the Bekasi district that has the potential to be developed to increase the value of PPH (Hendriwideta, 2018).

3.3 Vegetables

Types of vegetables with the highest consumption level were shallots and chilies with a percentage of 51%, while kluwih received the lowest consumption value of 0% with a frequency of more than seven times a week. Shallots and chilies are included in the group of vegetables that are used as cooking spices. Shallots are a type of root vegetable, while chilies are included in fruit vegetables. Shallots are used in three types of basic seasonings for Indonesian cuisine, namely white, red, and yellow seasonings. Chili is also a type of fruit vegetable that is widely consumed because it is commonly used as a spice and a complement to cooking. Shallots contain nutrients and active chemical compounds that have pharmacological effects so they are very beneficial for health (Aryanta, 2019). Therefore, Indonesian people in general can consume shallots and chilies every day, both for use in cooking spices and as a complement to dishes such as fried onions and chili sauce.

3.4 Fruits

Types of fruit with the highest consumption rate were bananas and papaya with a percentage of 15%, and cantaloupe had the lowest consumption rate with a percentage of 3% with a frequency of consumption of more than seven times a week. Bananas are also a local food ingredient that has the potential to increase PPH in the Bekasi district (Hendriwideta, 2018). A banana is a fruit that can be consumed directly or made into various preparations such as fried bananas, banana compote, banana cake, and so on. Papaya is a tropical fruit that is commonly consumed fresh both young (unripe) and ripe (ripe). Papaya contains a variety of nutrients such as pro-vitamin A, pro-vitamin C, B vitamins, lycopene, and dietary fibre (Kurnia, 2018). Papaya and banana are also known as table fruits, namely fruits that are consumed after the main meal.

3.5 Land Animals and Their Processed Products

Beef meatballs are a food ingredient in the group of land animals and their processed products with the highest consumption rate of 10%, while buffalo and smoked meat get the lowest score of 0% with a consumption frequency of more than seven times a week. Meatballs are processed meat products made from livestock meat with the addition of starch and spices, with or without the addition of other permitted food ingredients, round, or other shapes, and cooked. Meatballs are an alternative source of animal protein that is popular with the public (Indonesian National Standard, 2014)

Table 2. Results of Mapping Patterns of Consumption of Tubers

Foodstuff	Never	Once a week	a week 2-3 times	a week 4-6 times	a week 7 times	a week > 7 times a week	Amount
Sweet potato	26	36	14	10	6	8	100
Cassava	15	28	26	18	2	11	100
Potato	27	33	16	11	6	7	100
Taro	68	20	6	3	0	3	100
Tapioca	50	27	16	4	1	2	100

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Table 3. Results of Mapping of Vegetable Consumption Patterns

Foodstuff	Never	Once a week	a week 2-3 times	a week 4-6 times	a week 7 times	a week > 7 times a week	Amount
Garlic	7	18	8	10	6	51	100
Onion	5	20	8	13	4	50	100
Carrot	58	15	7	8	3	9	100
Turnip	12	25	26	13	4	20	100
Celery	77	10	4	3	1	5	100
Chilli	22	26	15	11	7	18	100
Tomatoes	5	21	12	4	7	51	100
Cucumber	6	23	11	7	7	46	100
Round Green Eggplant	7	27	15	13	8	30	100
Round Purple Eggplant	28	35	14	7	6	10	100
Long Green Eggplant	36	29	21	6	1	7	100
Long Purple Eggplant	54	18	14	5	2	7	100
bitter gourd	36	24	20	8	4	8	100
Peppers	46	30	12	4	3	5	100
Pumpkin	85	6	3	3	2	1	100
Long beans	37	29	15	8	4	7	100
Young Jackfruit	22	33	21	7	5	12	100
Kluwih	67	17	6	2	2	6	100
Water spinach	85	6	4	2	3	0	100
Spinach	9	34	24	13	5	15	100
Mustard	10	36	22	14	4	14	100
Leek	12	40	16	13	4	15	100
Green Beans Leaves	14	33	24	8	9	12	100
Siamese Pumpkin Leaves	64	15	12	6	1	2	100
Cassava leaves	73	14	6	2	4	1	100
Papaya leaf	51	25	11	7	3	3	100
Cabbage	60	19	11	5	2	3	100
Cauliflower	21	35	21	8	3	12	100
Turi Flowers	47	24	16	8	3	2	100
Garlic	90	5	3	2	0	0	100

Table 4. Results of Mapping of Fruit Consumption Patterns

Foodstuff	Never	Once a week	a week 2-3 times	a week 4-6 times	a week 7 times	a week > 7 times a week	Amount
Mango	10	40	21	13	5	11	100
Mangosteen	34	32	13	13	1	7	100
rambutans	35	33	19	6	2	5	100
Hamlet	33	35	16	6	4	6	100
Breadfruit	52	30	10	2	2	4	100
Sapodilla	46	29	13	5	1	6	100
Guava	27	36	17	5	2	13	100
Star fruit	51	31	8	4	1	5	100
Jackfruit	51	22	12	9	1	5	100
Soursop	60	22	7	6	0	5	100
Orange	14	39	20	14	2	11	100
Snake fruit	32	36	13	7	2	10	100
Pineapple	42	29	12	8	1	8	100
Banana	19	30	23	11	2	15	100
Pawpaw	24	31	14	13	3	15	100
Melon	36	32	11	7	4	10	100
Watermelon	28	39	11	7	4	11	100
Cantaloupe	72	16	4	3	2	3	100
Timun Suri	53	23	12	2	3	7	100

Table 5. Results of Mapping Consumption Patterns of Land Animals and Their Processed Products

Foodstuff	Never	Once a week	a week 2-3 times	a week 4-6 times	a week 7 times	a week > 7 times a week	Amount
Cow	66	18	8	1	2	5	100
Goat	77	14	2	2	2	3	100
Buffalo	98	2	0	0	0	0	100
Beef sausage	61	17	12	4	2	4	100
Beef Meatballs	29	34	16	8	3	10	100
Smoked meat	98	2	0	0	0	0	100
cornet	88	0	9	0	1	2	100

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3.6 Poultry, Flying Animals, and Their Processed Products

The types of foodstuffs in this category with the highest consumption rate were chicken meatballs (12%) and quail with the lowest score (0%) with a consumption frequency of more than seven times a week. Chicken meatballs are another variation of meatballs by using chicken as the main ingredient to produce meatball products at a more affordable price. The characteristics of chicken meatballs are almost like beef meatballs, including having a chewy texture due to fibre.

3.7 Aquatic Animals

The type of food in the aquatic animal group with the highest consumption value was tilapia fish with a percentage of 12%, while mackerel fish got the lowest percentage, namely 0% with a consumption frequency of more than seven times a week. Many people in Pantai Mekar village have professions as fish fishermen and also fishpond cultivation (Aziz, Wijayanto, & Heri, 2016). Commodities from ponds such as tilapia fish are generally consumed by families as side dishes, processed by being marinated with various spices and then fried. The abundance of tilapia fish in Pantai Mekar village is one of the reasons for the high consumption of this type of fish by the surrounding community.

4. Conclusion

The food consumption pattern of the community in the scope of households in Muara Gembong village is still classified as less varied because it still focuses on one type of food with a high level of consumption.

Some foodstuffs with high levels of consumption with a frequency of more than seven times a week are white rice, cassava, shallots, chilies, papaya, bananas, beef meatballs, chicken meatballs, and tilapia fish. Most of these food ingredients are not local food products that exist and are cultivated in the village of Muara Gembong. This causes the local food that is there is not utilized and consumed by the surrounding community. This food consumption pattern needs to be developed and made diverse so that local food ingredients that have potential as future food ingredients can be utilized from now on. The strategy of diversification and utilization of food in Muara Gembong village can be a strategy to strengthen regional food security so that the availability of food can be utilized to improve the health and nutrition quality of the community. This research is expected to be a first step in helping improve food security in the village of Muara Gembong so that potential food ingredients can be identified that can be utilized and developed as future food ingredients based on local food ingredients.

Table 6. Mapping Results of Poultry Consumption Patterns, Flying Animals, and Yields Processed

Foodstuff	Never	Once a week	a week 2-3 times	a week 4-6 times	a week 7 times	a week > 7 times a week	Amount
Chicken	4	28	38	16	3	11	100
Duck	52	23	12	4	3	6	100
Pigeon	98	1	1	0	0	0	100
Quail	99	0	1	0	0	0	100
Grouse	97	2	1	0	0	0	100
Chicken Nuggets	55	20	0	15	5	5	100
Chicken Meatballs	30	28	19	7	4	12	100

Table 7. Results of Mapping Patterns of Consumption of Aquatic Animals

Foodstuff	Never	Once a week	a week 2-3 times	a week 4-6 times	a week 7 times	a week > 7 times a week	Jumlah
Tilapia fish	22	24	25	10	7	12	100
Gurame	80	6	10	0	3	1	100
Pomfret	74	7	10	4	0	5	100
Catfish	67	11	13	6	0	3	100
Goldfish	63	17	10	6	1	3	100
Milkfish	16	17	31	20	6	10	100
Kedukang Fish	93	3	2	0	0	2	100
Nine fish	66	17	7	3	2	5	100
Snapper	79	14	6	0	0	1	100
Kurofish	77	9	9	1	0	4	100
Mackerel	88	8	2	2	0	0	100
Pompano	84	11	2	1	0	2	100
Shrimp	34	25	15	12	3	11	100
squid	55	22	11	3	2	7	100
Shell	59	22	10	3	3	3	100
Rebon	56	18	15	3	1	7	100
Fresh Anchovies	54	16	15	4	3	8	100
Salted Anchovies	39	27	14	7	3	10	100

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, analysis, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

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Optimization of The Manufacturing Process of Fried Instant Corn Noodles Using Response Surface Methodology

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Instant corn noodles can be manufactured using the air drying and frying process. This study aimed to determine the optimum process parameters and emulsifier concentration to produce instant corn noodles from 100% corn flour with relatively good quality characteristics using a cooking-forming single screw extruder. This study consisted of two stages, namely the determination of corn noodles with the fastest cooking time using emulsifier concentrations of 0, 0.5, 1, and 1.5% from the weight of corn flour, as well as the optimization of the manufacturing process using Response Surface Methodology. Wet corn noodles were dried using dry air at room temperature and fried using deep fat frying. The results showed that the dry corn noodle with a 1% emulsifier has the fastest cooking time of 6.1 minutes to reach the optimum cooking level. The optimum process combination was a drying time of 0 minutes and a frying process at 115 °C for 10 minutes. The verification of this process showed that instant corn noodles' water content, cooking loss, and elongation percentage were 13.32%, 10.50%, and 127.48%, respectively, in a 95% confidence interval. In addition, the cooking time of these optimized instant corn noodles was 6.8 minutes.

1. Introduction

The development of non-wheat-based noodles such as rice (Charutigon et al., 2007), sago (Engelen et al., 2017), sorghum (Suhendro et al., 2000), and corn (Muhandri et al., 2011; Aminullah et al., 2019) noodles have been conducted by researchers. Muhandri et al. (2011) explained that corn noodle manufacturing to form sturdy structures relied on gelatinization, flour granule rupture, and retrogradation mechanisms. Corn noodles manufacturing, both in the form of wet and dry noodles, can be conducted using the extrusion method (Muhandri et al., 2011; Waniska et al., 1999; Subarna et al., 2012), as well as a combination method of calendering and extrusion (Subarna & Muhandri, 2013; Kusnandar et al., 2009). The dehydration process in noodles can be done using drying and frying processes that produce dried and fried instant noodles, respectively (Gatade & Sahoo, 2015). Dried instant corn noodles were developed using a fluidized bed dryer (Muhandri et al., 2019) and a tray dryer (Subarna and Muhandri (2013). Several materials were related to fried instant corn noodles, such as high-protein corn flour (Kalsum & Nirmagustina, 2009), local cornflour and sago starch (Ali et al., 2018), and resistant corn starch and green banana flour (Vernaza & Chang 2017). Olorunsogo et al. (2019) produced a noodle from a sweet potato, soybean, and corn flour mixture. These studies were done by mixing corn flour with other flour to improve the noodle textures. The texture improvement of instant corn noodles can also be conducted by mixing additional ingredients such as hydrocolloids or emulsifiers.

Some studies on emulsifiers for improving corn noodle textures, such as Subarna et al. (2012), which used Glyceryl Mono Stearate (GMS), and Taqi et al. (2018) used Propylene Glycol Alginate (PGA) to reduce cooking loss and hardness of corn noodles. Also, Ding & Ying (2013) reported that emulsifiers of polysorbate-60 (P60), and diacetyl tartaric esters of mono-glycerides (DATEM) improved springiness, firmness, and overall acceptability in fried instant noodles. Lipids can affect the texture and adhesiveness of the extrudates (Ilo et al., 2000). Emulsifiers are food additives in the form of surfactants closely related to the texture of food products. The interaction between emulsifiers, protein, and carbohydrates in starch-based food products can modify the products' rheological, textural, and shelf-life properties. Based on the previous studies, the optimization of 100% corn instant noodles by adding additives in emulsifiers has yet to be fully documented in the literature.

This research aimed to optimize the manufacturing process of fried instant corn noodles, which are added by DIMODAN® commercial emulsifier with an extrusion system using Response Surface Methodology.

2. Materials and Methods

The primary material for manufacturing corn noodles was 80 Mesh corn flour from PT FITS Bogor Life Science and Technology (Indonesia). Other ingredients were water, salt, and DIMODAN® commercial emulsifier. This research consisted of two main stages: determining the optimum emulsifier concentration to obtain the fastest cooking time for dry corn noodles and optimising the manufacturing process of fried instant corn noodles.

2.1. Determination of the optimum emulsifier concentration

The formula and process for manufacturing corn noodles were referred to by Muhandri et al. (2011). DIMODAN® emulsifiers (0%, 0.5%, 1%, and 1.5% by weight of corn flour) and corn flour were mixed. Then, the 2% NaCl salt (by weight of corn flour) was dissolved into water as much as 70% by weight of flour, and then this solution was added to the mixture using a hand mixer for 5 minutes.

The dough was put into a single-screw cooking-forming extruder type LE25-30/C (Labtech Engineering Co. Ltd.) with an extruder temperature of 90 °C and a screw speed of 130 rpm. Corn noodles were cut and shaped into a circle, then dried using a tray dryer for 24 hours at room temperature. After that, their optimum cooking time of them was tested. The selected emulsifier concentration was determined based on the fastest cooking time to reach the optimum cooking level of the noodle.

2.2. Optimization of the manufacturing process of fried instant corn noodles

Optimize the manufacturing process of fried instant corn noodles using Response Surface Methodology (RSM) with the Design Expert 7.0 (DX7) application with D-Optimal design. The objective of this stage was to determine three optimum parameters, namely drying time, frying temperature, and frying time, which were set in the range of 0 - 120 minutes, 105 - 125 °C, and 2 - 10 minutes, respectively. Hattunisa (2011) stated that a frying temperature of 130 °C would swell the noodle surface, so the research temperatures were set at less than 130 °C. Kim (1996) stated that generally, the industries use 90 - 120 seconds for the frying duration on the instant noodle, but due to low temperatures, the frying time was set in the range of 2-10 minutes. Responses used in this research were water content after frying, cooking loss, and elongation of instant noodles after the rehydration process. The research treatments were presented in Table 1, and the criteria listed in Table 2 determined the optimum conditions.

2.3. Product Analysis

2.3.1. The optimum cooking time

Measure the optimum cooking time using a hedonic test with a scalar test of 10 cm (Meilgaard et al., 2016)

Table 1. The experimental design of the optimization process

No.	Drying time (minutes)	Frying Temperature (°C)	Frying time (minutes)
1	48	105	5
2	120	125	10
3	120	105	10
4	75	112	2
5	120	117	5
6	0	125	7
7	120	105	2
8	0	113	7
9	0	112	2
10	78	125	2
11	49	117	10
12	48	105	5
13	0	105	10
14	46	118	5
15	120	105	10
16	120	115	10
17	0	105	10
18	0	125	2
19	120	105	2
20	120	125	10

Table 2. Criteria for factors and responses and the importance level of the optimization stage

Component		Criteria	Importance level
Factor	Drying time	*In Range*	3 (+++)
	Frying Temperature	*In Range*	3 (+++)
	Frying time	*In Range*	3 (+++)
Response	Water content after frying	*Minimize*	5 (+++++)
	Cooking loss	*Minimize*	3 (+++)
	Elongation	*Maximize*	3 (+++)

on raw, precooked, cooked, overcooked, and porridge attributes, where the distance for each attribute was 2.5 cm. The number of panellists in this research was nine trained panellists selected from 30 random panellists. Determination of the panellists referred to SNI/Indonesian National Standard 01-2346-2006 (Badan Standardisasi Nasional, 2006), which stated that the minimum number of standard/trained panellists in one test was six. The score was processed into a line relationship between the cooking level (y-axis) and cooking time (x-axis). The obtained line equation was used to find the optimum cooking time by entering a cooking level (y value) 5. The obtained cooking time was verified using the American Association of Cereal Chemist (2000) method, visually observing the noodles after cooking. The optimum cooking time was the time to cook the noodles until the white spot in the middle disappeared.

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2.3.2. Analysis of elongation percentage using the TA-XT2i Texture Analyser

Corn noodles were wrapped around the stationary and moving probes at a distance of 2 cm and a speed of 0.3 cm/s. The elongation was calculated using Eq. 1.

$$Elongation = \frac{break\ time\ (s) x\ 0.3\ cm/s}{2\ cm}\ x\ 100\% \qquad (1)$$

2.3.3. Analysis of water content (Association of Official Analytical Chemistry, 2005)

The water content of corn noodles was used in the cooking loss calculation. 3-5 g samples were weighed on a dry cup and then dried in an oven at 105 °C for 4-6 hours until a constant weight was achieved. The sample and the dry cup were cooled in a desiccator and then weighed. Water content on a wet basis can be calculated by Eq. 2.

$$Water\ content\ \left(\frac{g}{100} g\ wet\ material\right) = \frac{W - (W1 - W2)}{W} \times 100\% \qquad (2)$$

where W = sample weight before drying (g),
W1 = sample weight + empty dry cup (g), and
W2 = empty cup weight (g).

2.3.4. Analysis of cooking loss (Oh et al., 1985)

Determination of cooking loss on corn noodles was conducted by boiling 3-5 grams of noodles in 100 mL of water during the optimum time then the noodles were drained. The noodles were dried at 105°C until the weight was constant, then weighed again. Cooking loss was stated by following Eq. 3.

$$Cooking\ loss\ (\%) = \frac{Dry\ weight\ before\ boiling - dry\ weight\ after\ boiling}{Dry\ sample\ weight\ before\ boiling} \times 100\% \qquad (3)$$

3. Results

3.1. The optimum emulsifier concentration based on the fastest cooking time on dry corn noodles

The desired optimum cooking level has a value of 5 as the median value of the line given where the test results are presented in Table 3. Dry corn noodles without an emulsifier and with a 0.5% emulsifier have a cooking time of 7 minutes with cooking levels of 5.1 and 5.3, respectively. Adding 1% and 1.5% emulsifiers can accelerate the cooking time of dry corn noodles with a cooking time of 6 minutes and cooking levels of 5.4 and 5.1, respectively.

3.2. Optimization of the manufacturing process of fried instant corn noodles

Analysis of variance (ANOVA) evaluation for responses of water content after frying and elongation of instant corn noodles and cooking loss response are presented in Tables 4 and 5, respectively.

3.2.1. The response of water content after frying

The water content of processed food products is one of the parameters determining product shelf life. Water content is also a parameter of the adequacy of the dehydration process to classify pasta products as standard or not. Based on SNI 3551-2012 (BSN, 2012), dried and fried instant noodles have maximum water contents of 14.5% and 8%, respectively (wet basis). Gulia et al. (2014) explained that frying and drying processes would decrease the water content of instant noodles to 2 – 5% and 8 – 12%, respectively. The suggested model on the water content response after frying is linear, as shown in Eq. 4.

Water content = 69.559 + 0.000A – 0.442B – 0.748C (4)

where A is the drying time (minutes), B is the frying temperature (°C), and C is the frying time (minutes). The relationship of water content after frying with these factors can be seen in Figure 1.

Table 3. Emulsifier concentration on cooking level of dry corn noodles

Emulsifier concentration (%)	Cooking time (minute)	Cooking level	Linier equation	R^2
0	7	5.1	y=0.6627x	0.9408
0.5	7	5.3	y=0.7156x	0.9415
1	6	5.4	y=0.8196x	0.9005
1.5	6	5.1	y=0.7341x	0.8076

Table 4. Analysis of variance evaluation of a linear model for responses of water content and elongation after frying and elongation of instant corn noodle

Source	df	Water content after frying			df	Elongation		
		Coefficient	Sum of squares	P value		Coefficient	Sum of squares	P value
Model	3	69.559	363.51	< 0.0001‡	3	820.456	50017.42	< 0.0001‡
A-Drying time	1	< 0.0001	0.058	0.9225	1	– 0.219	2421.21	0.1666
B-Frying temperature	1	– 0.442	249.97	< 0.0001‡	1	– 6.092	47579.45	< 0.0001‡
C-Frying time	1	– 0.748	124.13	0.0004‡	1	– 1.871	776.39	0.4239
Residual	16		102.27		16		18445.99	
Lack of fit	11		101.54	0.0001	11		18416.18	< 0.0001
Pure error	5		0.73		5		29.82	
Total	19		465.78		19		68463.42	
R^2		0.7804				0.7306		
Adj-R^2		0.7393				0.6801		
Pre-R^2		0.6652				0.6227		
Adeq Precision		13.106				9.755		

‡Significant at 5% level; df, degree of freedom

Table 5. Analysis of variance evaluation of a mean model for cooking loss response

Source	df	Coefficient	Sum of squares	P value
Model	0	10.52	0.000	
Residual	19		280.87	
Lack of fit	14		279.73	< 0.0001
Pure error	5		1.14	
Total	19		280.87	
R^2		0.4370		
Adj-R^2		0.1772		
Pre-R^2		-1.1810		
Adeq Precision		4.589		

df, degree of freedom

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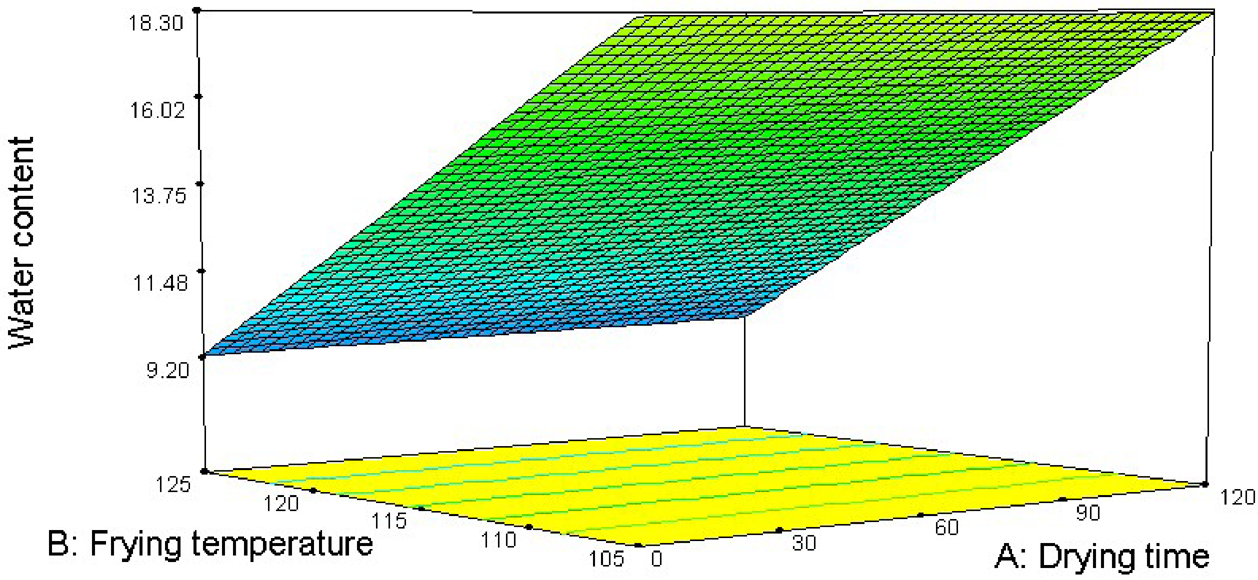

Figure 1. Three-dimensional graph of water content after frying response;
Water content (%) Drying time (minutes), frying temperature (°C)

3.2.2. The response of elongation

A high percentage of elongation shows the characteristics of noodles that are not easily broken. The gelatinization process's adequacy greatly determines the noodles' elongation percentage (Hattunisa, 2011). Analysis of Variance shows that the suggested model is linear (Eq. 5) and has a p-value smaller than 0.05, so the model has strong significance as an elongation response model.

Elongation = 820.456 – 0.219A – 6.092B – 1.871*C*
(5)

where A is the drying time (minutes), B is the frying temperature (°C), and C is the frying time (minutes). The influence of these factors can be determined by the three-dimensional graph in Figure 2.

3.2.3. The response of cooking loss

Cooking loss is one of the cooking quality parameters of instant noodle products. Cooking loss can be interpreted as the number of solid noodles dissolved in the water during cooking. This parameter indicates the ability of the product to maintain its structural integrity during the cooking process in boiling water (Liu, 2009). A three-dimensional graph of the cooking loss response is presented in Figure 3.

3.3. Optimum Process

An optimum process combination, predicted by the Design Expert 7 program shown in Table 6 and Figure 4, is obtained after determining the criteria for factors and responses and their respective importance levels. The selected process combination is a process combination that has a maximum desirability value close to 1.0.

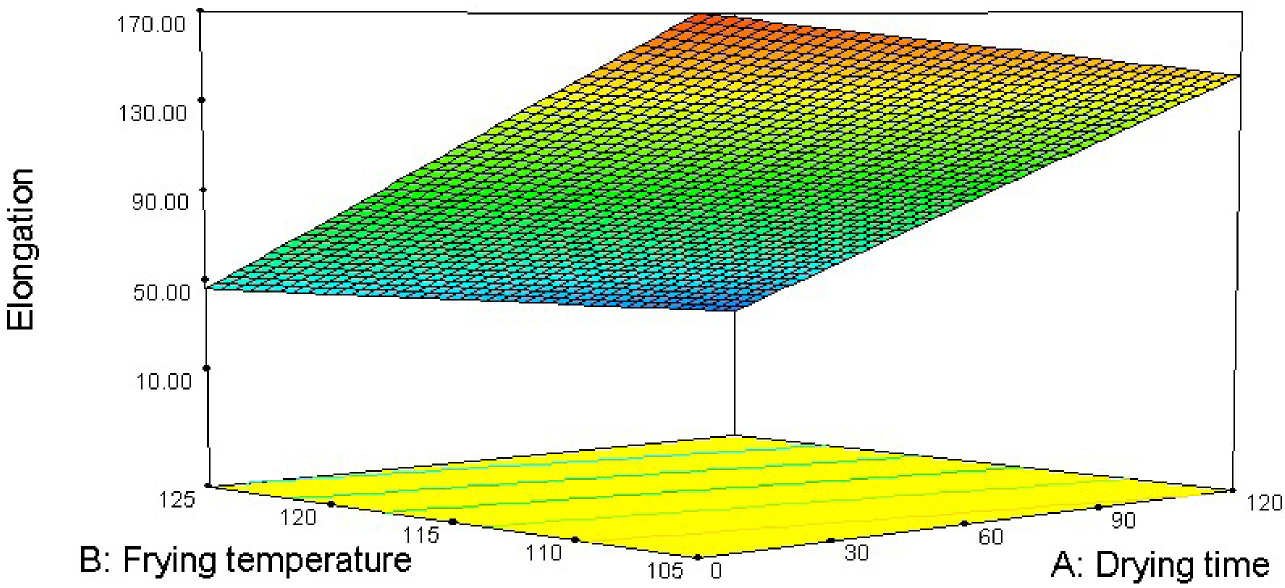

Figure 2. Three-dimensional graph of elongation response; Elongation (%) Drying time (minutes), frying temperature (°C)

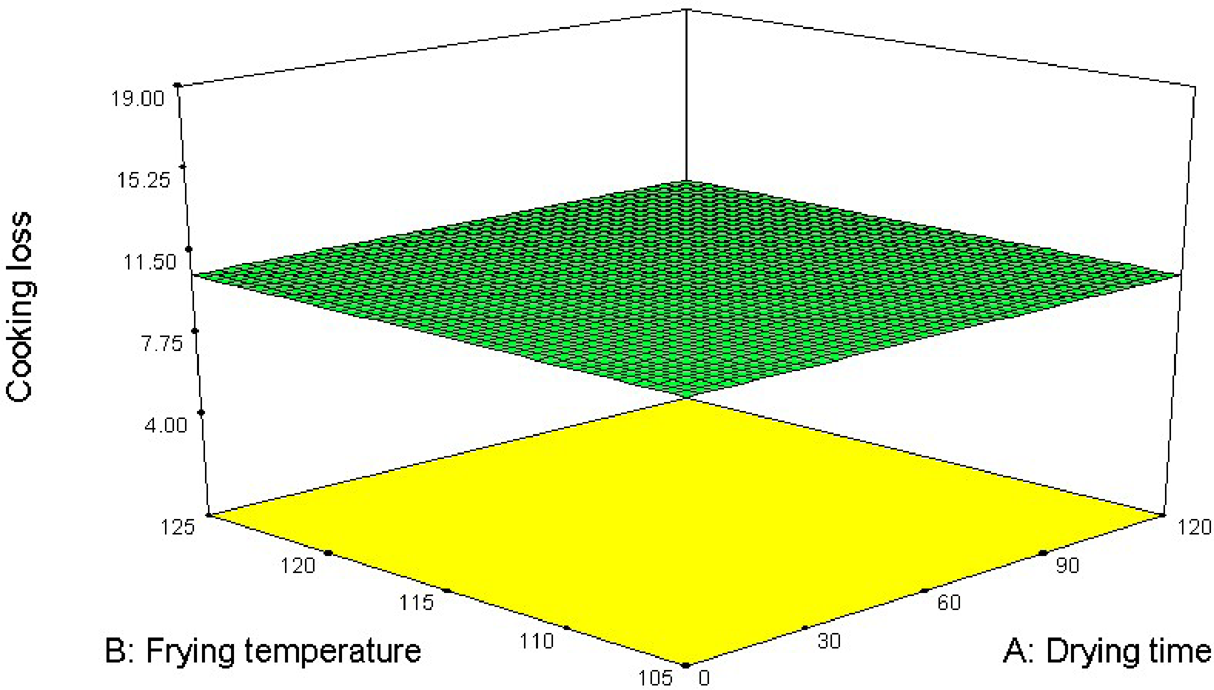

Figure 3. Three-dimensional graph of the cooking loss response; Coocking loss (%), Drying time (minutes), frying temperature (°C)

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Table 6. Desirability values for various process combinations

No	Drying time (min)	Frying temperature (°C)	Frying time (min)	Water content after frying (%)	Cooking Loss (%)	Elongation (%)	Desirability
1	0	115	10	11.28	10.52	100.87	0.649§
2	0	116	10	11.07	10.52	98.06	0.648
3	0	115	10	11.20	10.52	99.25	0.648
4	3	115	10	11.15	10.52	98.56	0.647
5	3	115	10	11.33	10.52	100.86	0.647
6	5	115	10	11.42	10.52	101.69	0.646
7	0	112	10	12.44	10.52	116.91	0.645
8	0	117	10	10.66	10.52	88.42	0.640
9	43	112	10	12.80	10.52	111.81	0.628
10	51	115	10	11.49	10.52	91.91	0.627

§selected process combination

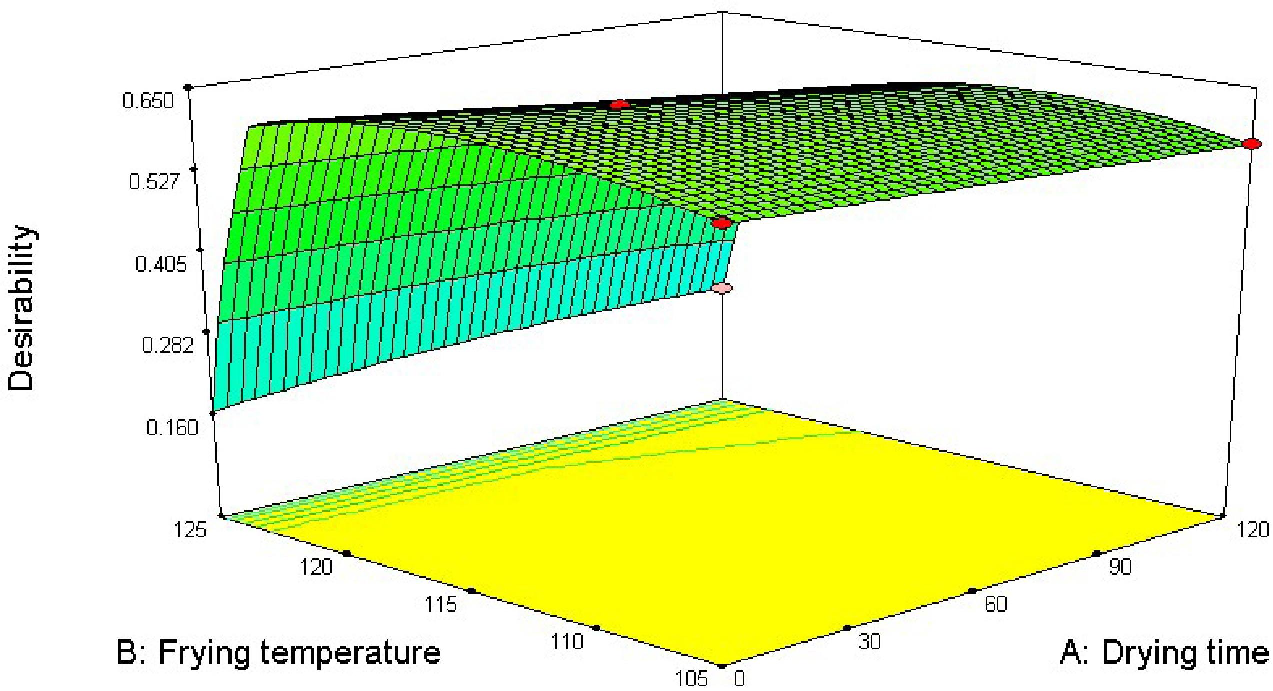


Figure 4. Three-dimensional graph of the optimum process combination; Desirability(%), Drying time (minutes), frying temperature (°C)

3.3.1. Verification and characterization of the quality of the optimized instant corn noodles

The responses in the selected process combination are then verified by comparing them against the actual condition, presented in Table 7. The Design Expert 7.0 program will give CI (Confident Interval) and PI (Prediction Interval) values at a significance level of 5%. The CI value indicates that 95% of the population will be between the mean and standard deviation, and only 5% will be outside it (Navidi, 2006).

3.3.2. Verification of the optimum cooking time of the instant corn noodle

The actual cooking time for optimum instant corn noodles needs to be verified. This verification uses organoleptic methods and visual observations of the white spots in the middle of the noodle's string. Determination of organoleptic cooking time is conducted by testing the cooking level of the noodles at various cooking times. The results are then processed into a regression equation, and the optimum cooking time is determined when the noodles reach the optimum cooking level (value 5). A graph of the cooking level at various cooking times is presented in Figure 6, and visual observation of noodles after rehydration is shown in Figure 7.

4. Discussion

4.1. The optimum emulsifier concentration based on the fastest cooking time on dry corn noodles

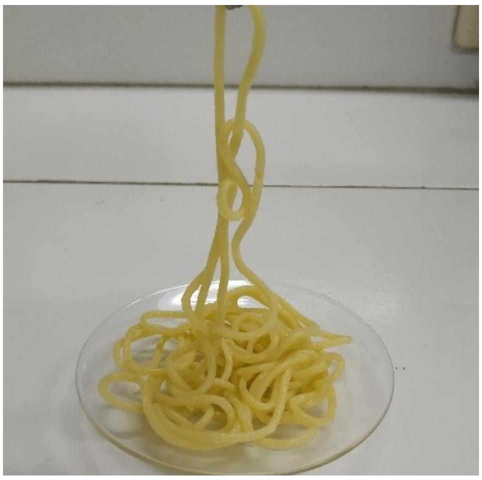
Table 3 shows that the emulsifier addition can accelerate the cooking time of dry corn noodles; however, this is only effective until the emulsifier addition of 1%. This result is in line with Subarna et al. (2012), which stated that adding more than 1% GMS to corn noodles no longer significantly improved the quality

Table 7. Response prediction and verification of the optimum process

Response	Prediction	Verification	95% CI Low	95% CI High	95% PI Low	95% PI High
Water content (%)	11.28	13.32	8.81	13.74	5.38	17.17
Cooking loss (%)	10.52	10.50	8.72	12.32	2.27	18.76
Elongation (%)	100.87	127.48	67.78	133.97	21.65	180.09

The appearance of the optimized instant corn noodles is presented in Figure 5.

(a)



(b)

Figure 5. The optimized instant corn noodles (a) before and (b) after rehydration process

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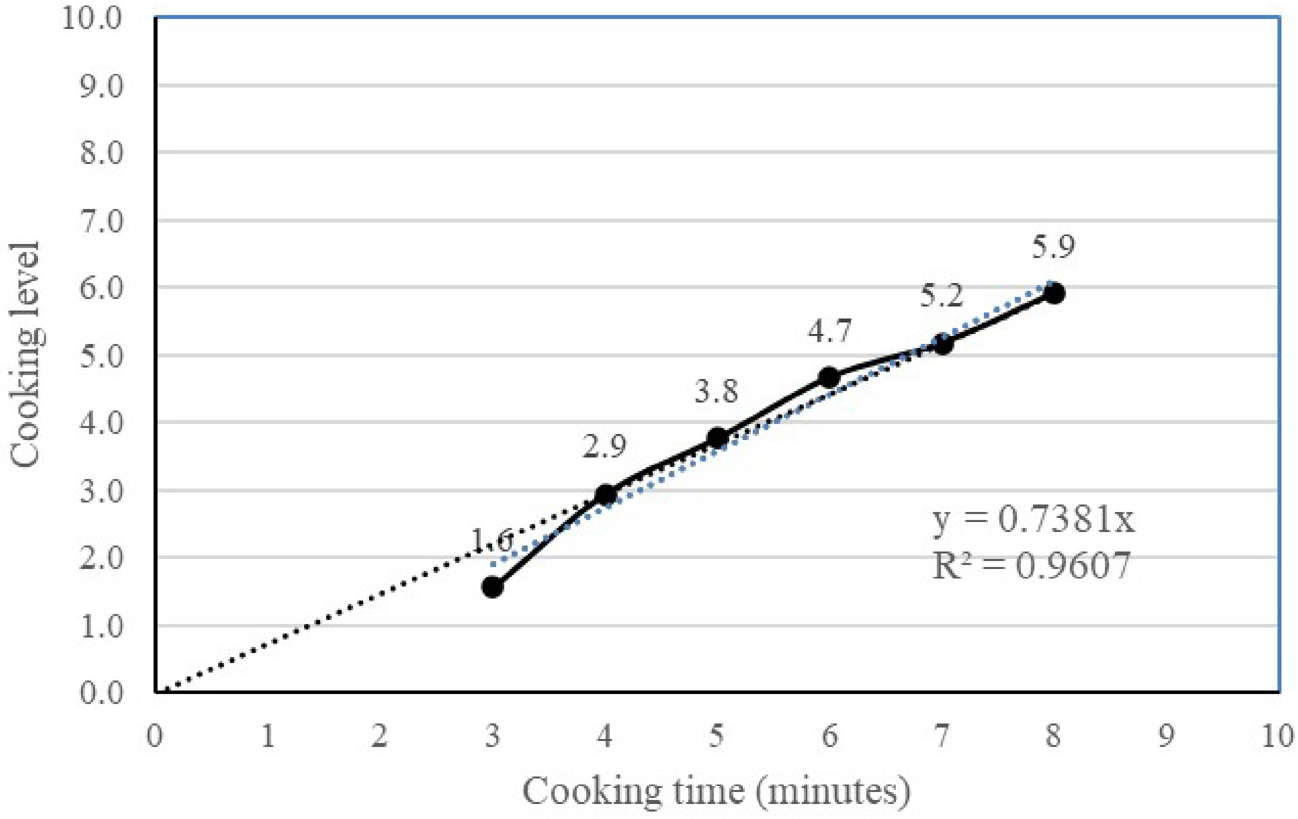

Figure 6. Cooking level of instant corn noodles at various cooking times

Figure 7. Visual observation of rehydrated instant corn noodles

of corn noodles. The emulsifier addition can improve the quality of corn noodles; however, too much addition will have negative impacts, such as increased cooking loss and the noodles being too dry. Corn noodles, adding 1% emulsifier, reach an optimum cooking level with a cooking time of 6.1 minutes (6 minutes 6 seconds). Distilled monoglycerides form a mesomorphic layer between water and the emulsifier (Chen, 2015). This property implies that the water will be easily bound to the noodles during cooking, resulting in faster cooking times.

4.2. Optimization of the manufacturing process of fried instant corn noodles

4.2.1. The response of water content after frying

Table 4 shows that the model has a p-value of less than 0.05, so the model has strong significance as a response model for water content after frying. The R^2 value of the water content response model after frying is 0.7804. This value means the selected model can explain 78.04% of the available data. The model has an adeq precision more significant than 4. This model also has high Adj R^2 and Pred R^2 values of 0.7393 and 0.6652, respectively, which means that the selected model can represent 73.93% of the actual value and 66.52% of the predicted value.

Table 4 shows that drying time has no significant effect on the water content of instant corn noodles. The drying process, set in the range of 0 - 120 minutes, may not be enough to decrease the water content of corn noodles after frying. The drying process is conducted using a tray dryer at room temperature. Subarna and Muhandri (2013) suggested that 60 °C for 40 minutes of low-temperature drying can produce good physical quality dry corn noodles. The drying process in corn noodles is different from that in spaghetti. Baiano et al. (2006) explained that good quality spaghetti, in terms of cooking and sensory, was obtained by drying at a high temperature of 90 °C for 5 hours. Using high temperatures in the drying process of corn noodles can crack the noodle surface and produce lower elongation and rigidity of corn noodles. In addition, Frying time affects the water content of corn noodles, where the higher the frying temperature leads to the lower the water content of instant corn noodles at a certain point. It is found that the lowest water content that can be achieved is 6.8%, and the highest is 23.48%. The frying process is the evaporation process of replacing water mass in materials with oil (Dana & Saguy, 2006). The higher the frying temperature, the further away from the water's boiling point so that the water's mass will more quickly turn into a mass of water vapour and come out from the materials. The evaporation process of the mass of water will create shaft holes in the string of fried instant noodles, so water is easier to penetrate the strands of noodles during the rehydration process, which impacts the faster cooking time of corn noodles (Gulia & Khatkar, 2013).

4.2.2. The response of elongation

The R^2 value of the elongation response model is 0.7306, which means 73.06% of the available data can be explained by the selected model and the model, which has adeq precision more significant than 4. This model also has high Adj R^2 and Pred R^2 values of 0.6801 and 0.6227, respectively, which means that the selected model can represent 68.01% of the actual value and 62.27% of the predicted value.

Table 4 shows that frying temperature is a significant factor in the elongation response, while drying and frying times have no significant influences. Figure 2 shows that the higher the frying temperature, the lower the elongation of instant corn noodles. The frying process at a high temperature can release the water from the noodle strands and immediately make holes/pores in the shape of small and uniform sponges (McDonough et al., 2001). However, based on Table 4, drying and frying times have no significant effect on the noodle elongation, although Eq. 5 shows negative coefficients for them, which implies that the longer the drying and frying times, the lower the elongation of instant corn noodles. Subarna and Muhandri (2013) explained that drying at low temperatures can produce noodles with more minor structural changes. These changes can strengthen the structure of noodles and make the noodles have higher elongation after rehydration. The gelatinized starch has a strong matrix, so air does not easily escape from the strand because the formed crust layer on the noodle surface blocks it. The crust surface, pushed by the water vapour, can be identified as the swelling on the noodle surface. This condition indicates that the noodles will break when rehydration is applied (Hattunisa, 2011).

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4.2.3. The response of cooking loss

Table 5 shows that the cooking loss response has a mean model because it does not produce a model with a significant p-value. An insignificant response indicates that combining the drying and frying processes does not influence the cooking loss of instant corn noodles. This condition is supported by a negative pred-R^2, which implies that the overall mean is a better predictor for the response.

Figure 3 provides further information that the three independent variables do not significantly affect the cooking loss of instant corn noodles. Similar results were confirmed by Subarna & Muhandri (2013) and Lee et al. (2005), which reported that the drying process had no significant effect on the cooking loss of dry corn noodles. Hattunisa (2011) stated that the frying process in corn noodles could increase the cooking loss. This increase can occur due to holes/pores in the noodle strand during the frying process, which results in the ease of starch particles on the noodle strand detached during cooking. The easier the starch particles detach, the higher the cooking loss of noodles after rehydration.

4.3. Optimum Process

4.3.1. Verification and characterization of the quality of the optimized instant corn noodles

Table 7 shows that the actual values of all responses are in the range of 95% CI, and the model can be used to predict the responses. Howell (2008) defined CI as a range of values containing the probability value of the tested parameter. Moreover, Heiberger & Holland (2004) explained that the narrower range of CIs shows better optimization values. The actual water content of the optimum instant corn noodles is 13.32%. This value is still in the program prediction range of 8.81 - 13.74%. This actual value is similar to Olorunsogo et al. (2019), who reported that instant noodle from a blend of sweet potato, soybean, and corn flour has a water content of 13.17%. Even so, the water content in this research is higher than that of instant noodles from a mixture of corn and tapioca flours by 6.22% (Pato et al., 2016). Water content that is still relatively high can occur due to using a relatively low frying temperature compared to the commercial frying temperature conducted in the industry. The frying process for the commercial instant noodle is usually conducted at 150-180 °C for 90-120 seconds (Kim, 1996). The lower the frying temperature, the lower the evaporation rate of the water mass so that it can cause the water content to remain high enough. Low temperatures with a long frying duration cause the appearance of instant corn noodles to look greasy.

The actual cooking loss of instant corn noodles is 10.50%, in 95% CI and 95% PI. Charutigon et al. (2007) explained that consumers could accept noodles with a cooking loss of less than 12.5%. This cooking loss is higher than that of dry corn noodles, which is 4.56% (Muhandri et al., 2011). The frying process can influence the high cooking loss of instant corn noodles. Using high temperatures in the frying process can immediately change the water into water vapour and push the starch component into the noodles. This push can form a sponge-like structure in the noodle strand, which releases the starch particles quickly during the frying process. In addition, the elongation percentage of instant corn noodles is 127.48%, which is good enough for pasta products. Instant corn noodle has a good structure, are compact, and are not easily broken when drained. High elongation means the high extensibility of noodles when pulled under a specific force.

4.3.2. Verification of the optimum cooking time of the instant corn noodle

Figure 6 shows a graph of the relationship between the cooking level of instant corn noodles and the cooking time to produce a linear equation of $y = 0.7381x$ with an R^2 of 0.9607. The y value is the cooking level of the noodles, while the x value represents the cooking time of the noodles. It can be seen by entering the y value of 5 in the equation (the desired optimum cooking level) that the actual cooking time to produce the optimum cooking level of instant corn noodles is 6.8 minutes, equivalent to 6 minutes and 48 seconds. The disappearance of the white spot in the middle of the noodles marks this optimum cooking time. In addition, This R^2 indicates a solid relationship between the cooking level and the cooking time of the noodles on the linear line.

This cooking time is longer than that of dry corn

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noodles in the previous stage, which is 6.1 minutes. It can be caused by the amount of absorbed oil by the noodles. Oil and water are two substances that cannot be mixed due to their different specific densities. Oil binding to the noodle structure inhibits water penetration during the rehydration process. The oil in instant noodles can reach 20% of the product's total weight. Cooking starch at temperatures more than 107 °C produces the amylose-lipid complex structure. This structure can inhibit the starch's swelling and solubility during the cooking process (Sittipod & Shi, 2016) and take the longer cooking time of instant corn noodles.

Data in Figure 6 are supported by visual observation of the white spots present after rehydration in Figure 7. The optimum cooking time is defined as the cooking time needed for the noodles until the disappearance of the white spot in the middle of the noodle strands when pressed between two glass plates (Marti et al., 2010).

5. Conclusion

Adding a DIMODAN® type emulsifier at a 1% level (by weight of flour) accelerated the cooking time of dry corn noodles to 6.1 minutes from corn noodles without adding an emulsifier (7 minutes). Optimization of the manufacturing process of fried instant corn noodles using the D-optimal RSM showed that the optimum process was a combination of a drying time of 0 minutes and a frying temperature of 115 °C for 10 minutes. This optimum process produced instant corn noodles with a water content of 13.32% (wet basis), cooking loss of 10.50%, and elongation percentage of 127.48%, while the optimum cooking time for this instant corn noodle was 6.8 minutes.

Conflict of interest

The authors declare no conflict of interest.

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Food Typology of Traditional Foods Based on Millet, Sorghum, and Cowpea from the Rural Communes of the North Central Region of Burkina Faso

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traditional food; millet; sorghum; cowpea; nutrition; Burkina Faso

Food vulnerability is a growing plague in developing countries, neglecting local foods. Better knowledge of local foods is necessary to improve their consumption. The objective of this study is to identify the types of local millet, sorghum, and cowpea foods in the North Central Region from a socio-cultural perspective. The methodology consisted of organizing 12 focus groups to respond to an individual questionnaire on the socio-cultural characteristics of participants and their knowledge of their millet, sorghum, and cowpea-based diet. The focus groups targeted women and men in the young, adult, and senior age groups in the communes of Lebda and Boussouma. Among the traditional dishes inventoried, 25 commonly consumed dishes were selected and reproduced by rural women. A total of 44 traditional foods, 3 improved traditional foods, and 4 imported foods based on millet, sorghum, and cowpea were inventoried. Socio-cultural knowledge of these foods differed by age group but was identical for the two rural communes. Among these foods, some are consumed routinely or occasionally, while others are specific to vulnerable groups. Knowledge of the types of foods will help guide nutrition policy to promote the consumption of some types of foods.

1. Introduction

Food is one of the most important elements of every nation's traditional culture. food traditions play a central role in society and also human behaviour (UNESCO, 2021). Culturally appropriate and diverse, healthy diets contribute to food and nutrition security. Some research has highlighted the value of considering the diet as a whole by identifying food typologies, the aim of which is to assess food consumption patterns (De Bourdeaudhuij and Van, 1999), (Gillman and al., 2002). In Burkina Faso, cereals and legumes are an important source of nutrients for its population (MAAH-DGESS, 2020). Among the main cereals consumed in Burkina Faso, sorghum, millet, and maize represent the majority of food consumption (about 70%).

Several studies have evaluated the nutritional potential of cereal grains (Songre-Ouattara and al, 2015) (Kowieska and al., 2011), (Malomo and al., 2013)). Sorghum carbohydrates make up 80% of the grain's dry matter. It contains 7-16% protein, 3-4% lipids, and 1.5-3% mineral contents of dry matter (Fliedel and al., 1996). Millet is highly palatable and rich in protein, minerals, and energy (Andrews and al., 1993) (Michaud and al., 2002). Millet contains an average of 67.5% carbohydrate, 11.6% protein, 5% lipids, and 2.3% mineral content of dry matter (Nambiar and al., 2011). Groundnuts, cowpeas, and voandzou are consuming more than 2 to 4 times a month by all households as a food item in Ouagadougou, Kaya, Lebda, and Nobéré (Hama-Ba and al., 2017). Cowpea is a vital legume for the food security and health of populations around the world with major nutritional and nutraceutical qualities (Hall, 2012). In developing regions, it is mainly grown for its seeds and leaves, and occasionally for the green pods (Gerrano and al., 2017). Whole cowpea grain contains 23-32% protein, 50-60% carbohydrates, and less than 1% fat (Jos´e and al., 2014) (Kirse and Karklina, 2015).

However, we note that eating habits are increasingly detached from food traditions, creating an alarming situation in the nutritional status of the low-income population. The Burkina Faso traditional food has an important place in the social and cultural customs. Specific traditional dishes are prepared for many traditional festivals. For example, there are celebrations to mark the start of the harvest and the beginning of the consumption of new crops. Traditional foods help avoid dependence on imported foods. They also help to promote and develop local crops, which are often neglected as a source of energy, even though they are better adapted to the environment. This is the case in Nigeria, Ghana, and other countries where it has been demonstrated that the development of local agricultural products stimulates technological innovation and traditional know-how (Mervin, 1998). The flooding of the markets with external products of undetermined quality has a strong influence on the nutritional status of the population. In addition to stunting, which will affect 24.9% of children under the age of five in 2020 (MS, 2019). Burkina Faso, like most developing countries, is affected by a nutritional transition leading to excess weight ((Finucane et al, 2011) (Ng et al, 2014) (Stevens et al, 2012)) which is accompanied by an increase in the incidence of high blood pressure (HTA) and diabetes (Popkin, 2015). The latter two are major factors in increasing the incidence of cardiovascular disease (CVD) and cancer (Diendere, 2017). The prevalence of hypertension, diabetes, total hypercholesterolemia, and obesity was 17.6%, 4.9%, 3.5%, and 2.1%, respectively, and the majority of the population (97.3%) was exposed to at least one common risk factor for no communicable diseases (STEPS, 2014).

The Centre-Nord region of Burkina Faso has the highest prevalence of stunting with 32.2%, including 10.1% of severe forms, and the lowest proportion of Centre-Nord dietary diversity scores in 2021. However, in the region, millet, sorghum, and cowpea are grown and consumed. These crops are used to produce local dishes, and a minority of these dishes constitute staple foods. Traditional know-how is a source of solutions to the current food problems facing our populations. The food process and food mixes that are highly nutritious are no longer known to today's populations but were very useful in the past. It is therefore important to know the dishes, the types of food commonly consumed, the dishes abandoned and to estimate their nutritional value. Knowledge of nutritional values will enable nutritionists to guide the population in their food intake and promote the consumption of certain abandoned dishes. This will help balance the population's diet. Numerous studies in Burkina Faso have revealed the existence of traditional dishes such as *tô*, porridge, couscous or *wesla*, cowpea fritters, *zoomkoom*, pancakes, etc. (Icard-Vernière and al., 2010) ; (Songre-Ouattara and al., 2016); (Kagambèga and al., 2019); (Soma and al., 2019)). Many traditional foods are disappearing. Some food is little known by the new generation. The youngest is increasingly integrating imported products. The promotion of food diversity, and the changing behaviours to ensure sustainable consumption are key elements of the global strategy to achieve the Millennium Development Goals. (UNESCO, 2021).

The objective of this study is to identify the types of millet, sorghum, and cowpea-based foods in the rural North Central region of Burkina Faso. This study will provide a better understanding of the place of traditional food in the current context of malnutrition and the control of certain chronic diseases.

The results of the study will benefit vulnerable people in households (children, pregnant women, lactating mothers, the elderly, and the sick). This will be done through policymakers who will pass laws for the promotion of local products, health professionals and community organizations who will be doing awareness campaigns, and processors and restaurateurs

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who will be responsible for preparing these dishes to make them available and accessible. These actions will help fight malnutrition and maintain the nutritional balance of patients suffering from non-communicable diseases due to poor nutrition.

2. Materials and methods

The methodology consisted of focus group discussions to answer an individual questionnaire and inventory of local millet, sorghum and cowpea foods, food preparation and nutritional analysis of foods.

2.1 Zone of study

The focus groups were conducted in the North Central region of Burkina Faso in the communes of Lebda and Boussouma. The commune of Lebda is located 25 km from Pissila on the Kaya-Boulsa axis. It is about 15 km from Kaya, the capital of the Centre North region in the province of Sanmatenga, and 120 km from the city of Ouagadougou. The commune of Boussouma is also located in Sanmatenga, 20 km from the city of Kaya. These two communes have a traditional organization. The foods were reproduced in Lebda.

2.2 Organization of focus groups

A total of twelve groups were formed in each commune according to the age and gender of the participants. Three age groups were considered: group G1, which represents the oldest people over 50 years old, group G2, which represents adults between 35 and 50 years old, and group G3, which represents young people between 15 and 35 years old. For each age group, 2 subgroups of men and women were created separately. The number of participants per focus was eight. Two agents were in charge of the animation. The discussion was facilitated in the local language "Mooré" which is a language commonly spoken in the North Central region. Each session lasted between 90 and 120 minutes and was recorded by dictaphones. The main selection criteria were membership in the commune and the function of the producer.

2.3 Questionnaire or guide

The interview guide focused on the social identification of the participants, the inventory, and the history of the dishes. The main discussion was oriented on the knowledge of millet, sorghum, and cowpea-based dishes and products, those commonly consumed, the abandoned dishes, new dishes, foods eaten during special occasions (festivals, funerals, christenings, traditional celebrations, etc.), foods eaten during the seasons (rainy season, harvest, welding periods), foods eaten by vulnerable groups (children, pregnant women, nursing mothers, the elderly and the sick). The categorization of foods into traditional, new, and specific occasional groups was described. Traditional foods have been defined as foods that are authentic to the region. New foods were defined as improved traditional foods and imported foods. Occasional foods were defined as foods eaten during festivals, baptisms, and funerals, such as temporal foods that are consumed during rainy seasons, harvest seasons, and welding periods. Specific foods were defined as foods for the nutritional recovery of children, pregnant women, postpartum women, the elderly, and patients.

2.4 Material

The millet (*Pennisetum glaucum*), sorghum (*Sorghum bicolor (L)*), groundnut (*Arachis hypogea (L)*), and cowpea (*Vigna unguiculata (L)*) used in this study were brought in by the women. The fruits and leaves of tamarind (*Tamarindus indica*), and the leaves of bagana (*Piliostigma reticulum*) were collected in the bush, shea butter, salt, oil, peanut powder, sesame seeds, cotton seed powder, and potash were obtained with the rural women and used as ingredients.

2.5 Preparation of food

2.5.1 Choice of women who prepare foods

The criteria for selecting the women were their experience in preparing food in their households and their regular consumption of local meals. Each woman was asked to choose the food she had mastered and to describe the steps involved in its preparation. The other participants were asked to amend and correct the steps if they had forgotten.

2.5.2 Food preparation diagram

The diagram for each food was created by the group supervisors following the descriptions of the different steps made by the women who were selected. The other participants are invited to amend and correct the steps in case of omission. At the end of the description of the preparation steps, the common unit steps of the different dishes were identified. The dish diagrams were summarized in a few diagrams based on the unit steps and the raw materials used. From the inventoried dishes a total of 25 commonly consumed dishes were selected for reproduction.

2.6 Statistical Analyses of the Data

Transcription of the focus group audio was done by verbatim in French. The data were entered into Excel 2016 according to the defined types of dishes. A thematic analysis was applied to the transcribed data. Statistical processing was carried out using SPSS software version 2020. Descriptive statistical analyses were carried out with the calculation of response frequencies.

3. Results

3.1 Socio-economic characteristics of focus group members

The socioeconomic characteristics of participants are represented in Table 1.

All of the focus group participants belonged to the Mossi ethnic group. They are mostly illiterate as 91% of the participants in Boussouma and 84% of the participants in Lebda have never attended formal school. The highest level of education was secondary school, with only 4% of participants in Boussouma and 6% of participants in Lebda.

The majority of participants in both communes were Muslim (75% of participants in Boussouma and 59% of participants in Lebda) and married (89% of participants in Boussouma and 96% of participants in Lebda). Most participants were indigenous (52% of participants in Boussouma and 69% of participants in Lebda). In addition to their production activities, some participants held secondary positions. These functions include animators, traders, gold miners, blacksmiths, herders, processors, students, and authorities (customary, religious, administrative. As for the origin of the participants, natives or indigenous

Table 1. Socio-economic characteristics of participants

Socio-economic parameters	Participants	Boussouma		Lebda	
		Number	Percentage (%)	Number	Percentage (%)
Religion	Total	44	100	49	100
	Christian	11	25	17	35
	Islamic	33	75	29	59
	Traditional		0	3	6
Ethnic group	Mossi	44	100	49	100
Educational level	Alphabetized	0	0	14	29
	Koran	3	5	2	4
	Not instructed	38	86	26	53
	Primary school	3	5	4	8
	Secondary school	2	4	3	6
Matrimonial status	Single	5	11	1	2
	Divorced	0	0	0	0
	Married	39	89	47	96
	Widowed	0	0	1	2
Profession	Other activities	30	68	8	16
Origin	Native	23	52	34	69
	Migrant	21	48	15	31

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people represented the majority in the focus groups and in both communes. However, in Boussouma, the percentage of migrants, defined as those who are not originally from the commune, tends to balance that of natives.

3.2 Inventory of traditional millet, sorghum, and cowpea foods

3.2.1. Inventory of foods by raw material

The dishes were grouped into simple dishes based on millet, sorghum, or cowpea and also into mixed dishes based on millet/sorghum and cowpea or/and leaves (see pictures in annex). The simple dishes were in turn grouped according to their mode of cooking into several forms, namely fried foods (pancakes, *samsa*), drinks (*zomkom, zomparga, dolo, pasta (tô, bengfallés)*, couscous (wesla) rolled dishes (benkida porridge, lumps), porridges (porridge, *kalbenga, pog-rogdo-benré*), foods cooked simply in water or steam (*banigula, foura, gonré, malguemnoré, guelbom, pigga).* These various inventoried foods are presented in the following Table 2.

Figure 1 illustrated types of food classified according to their respective raw materials and cited respectively, according to the commune, age, and gender of the participants.

According to the food type, the foods mentioned are the same in both communes. The largest proportion of cereal-based foods was cited by the G2 groups aged between 35 and 50 years, representing 57% of the total. Cowpea dishes were cited equally by G2, G1, and G3 and represented a small proportion of all foods (22-25 %). Cereal-cowpea, cereal-leaves, and cowpea-leaves dishes were cited infrequently by all groups. Cereal-based foods were equally cited by men and women, accounting for 57% and 56% of foods respectively. Cowpea-based foods were cited more by women than by men and accounted for 24% and 22% of foods respectively. Cereal-cowpea foods were the most cited by men. Cereal-leaves and cowpea-leaves foods were slightly more frequently mentioned by women than men, accounting for 2% and 1% of the foods mentioned, respectively.

3.2.2. Inventory by food history

The foods inventoried were grouped into two types of foods, traditional foods, and new foods. These new foods are composed of improved and imported traditional foods (see Table 2). Among these types of food, there is a classification of commonly consumed foods, occasionally consumed foods, and foods consumed by vulnerable groups.

Figure 2 shows the types of traditional foods categorized by history.

Improved and imported traditional foods inventoried by the focus groups are few These foods are composed of cereal-based foods, cowpea-based foods, and mixed foods (see Table 2). The new foods are enriched mugdugu, and millet/sorghum bread, enriched tô, gonsala, green_beans-wesla, and dèguè. Among these foods the bread, the dèguè and the green beans have been identified as imported foods. The enriched mugdugu, the enriched tô and the gonsala are improved traditional foods. These new foods also include commonly consumed foods, food specific to vulnerable groups and occasional food. The traditional foods were mostly simple foods (see Table 2). Among these foods, a large proportion disappeared, as shown in Figure 3. The disappearing foods that have been cited are, among others banigula, guelbom, kemogho, gouroum, malguemnoore, zabi/birba, kaloré, and muyamuya.

3.2.3. Specificity of the food

Some foods are commonly consumed, but others are consumed occasionally. These occasions are among others:
- the rainy season, which runs from June to October
- the harvest season which is from September to November - the lean season which overlaps with the rainy season (April to October)
- and the festive season (traditional festivals, religious festivals, weddings, and baptisms).

Others are eaten by vulnerable groups (children, pregnant women, the elderly, and patients). On the other hand, some foods are commonly consumed.

Table 2. Traditional millet, sorghum and cowpea food

Type foods	Simples foods	Raw material	Cooking mode	Composite foods	Raw materials	Cooking mode
Traditional foods	*banigula*	sorghum	with water	*babenda*	millet/sorghum +leaf	with water
	benga_cooked	cowpea	with water	*benga_mil*	cowpea + millet	with water
	bengfalle	cowpea	with water	*bengneton*	cowpea +leaf cowpea	with water+ steam
	porridge	sorghum/ millet	with water	*cowpea_wesla*	cowpea+sorghum/millet	water+ steam
	bessé	millet	juice	*coumwesla*	*millet+obergine*	with steam
	pog-rogdo-benré	millet	with water	*wesla_feuille*	millet+leaf	with steam
	dolo	sorghum	juice	*wesla_voandzou*	millet+voandzou	water+steam
	pancake	sorghum/millet	frying	*gnon/guilipon*	millet+leaf	with steam
	gonre	millet	with steam	*bengyissa*	millet+leaf cowpea	with steam
	gonsaala	cowpea	steam+water	*Bassi*	millet+groundnut	steam+ torrefied
	gouroum	millet	with water			
	guelbom	millet	with water			
	foura	millet	with water			
	kalbenga	cowpea	with water			
	kaloré	millet	with water			
	kemogho	millet	with water			
	malguemnoore	cowpea	with water			
	mouyamouya	sorghum	with water			
	pigga	millet	with steam			
	cowpea sauce	cowpea	soup			
	samsa	cowpea	frying			
	tô	sorghum/ millet	dough			
	Toubani	cowpea	with water			
	wesla	sorghum/ millet	with steam			
	zabi/birba	cowpea	with water			
	zomkom	millet	juice			
	zomparga	sorghum/ millet	juice			
Improved traditional foods				enriched *mugdugu*	millet+groundnut	torrefied
				enriched porridge	millet+cowpea/groundnut	with water
				enriched *tô*	millet/sorghum+legum	with water
Imported foods	bread	sorghum / millet + wheat	in oven	green bean _wesla	millet+ bean	with steam
	biscuits	millet/sorghum+wheat	in oven	*dègué*	millet+milk	with steam

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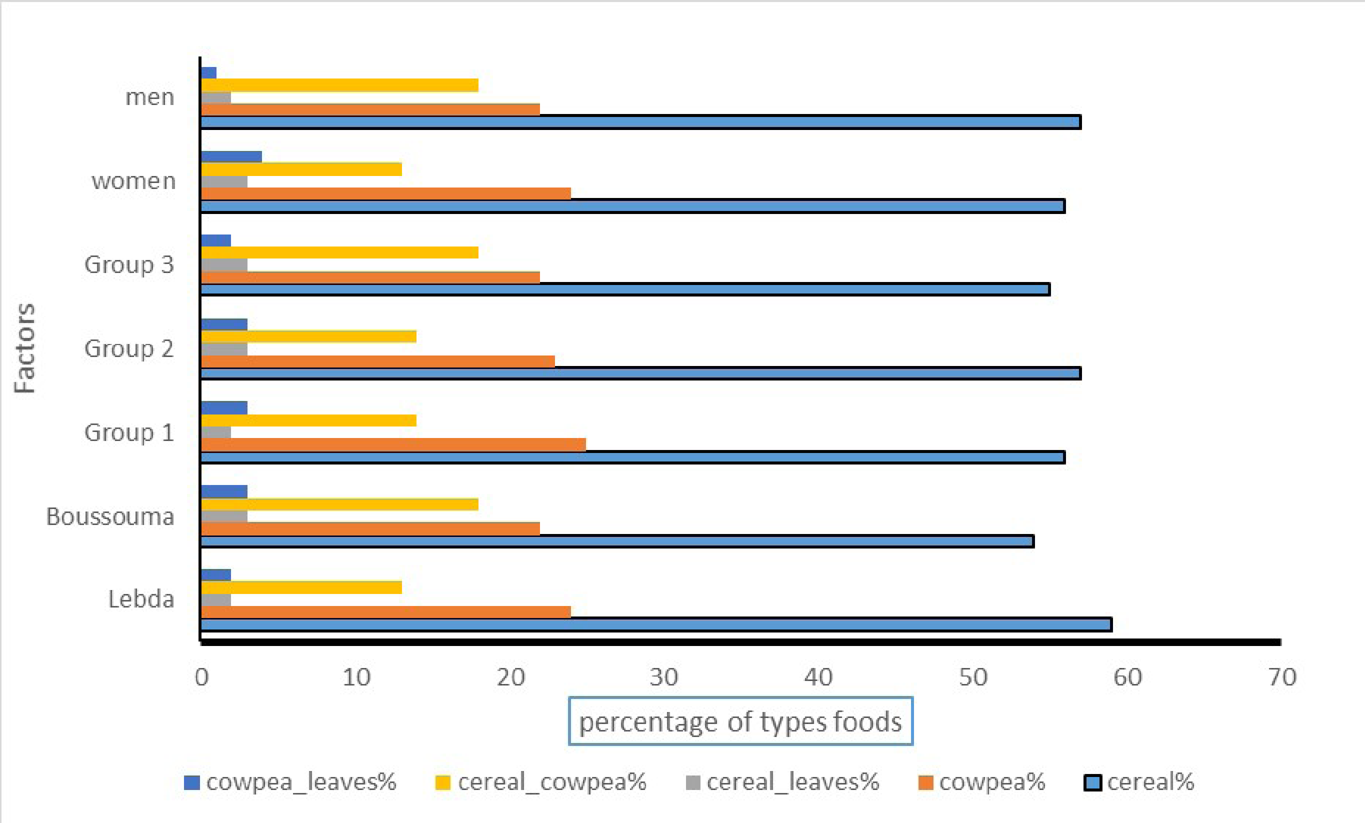

Figure 1. types of food classified by the commune, age group, and gender of participants

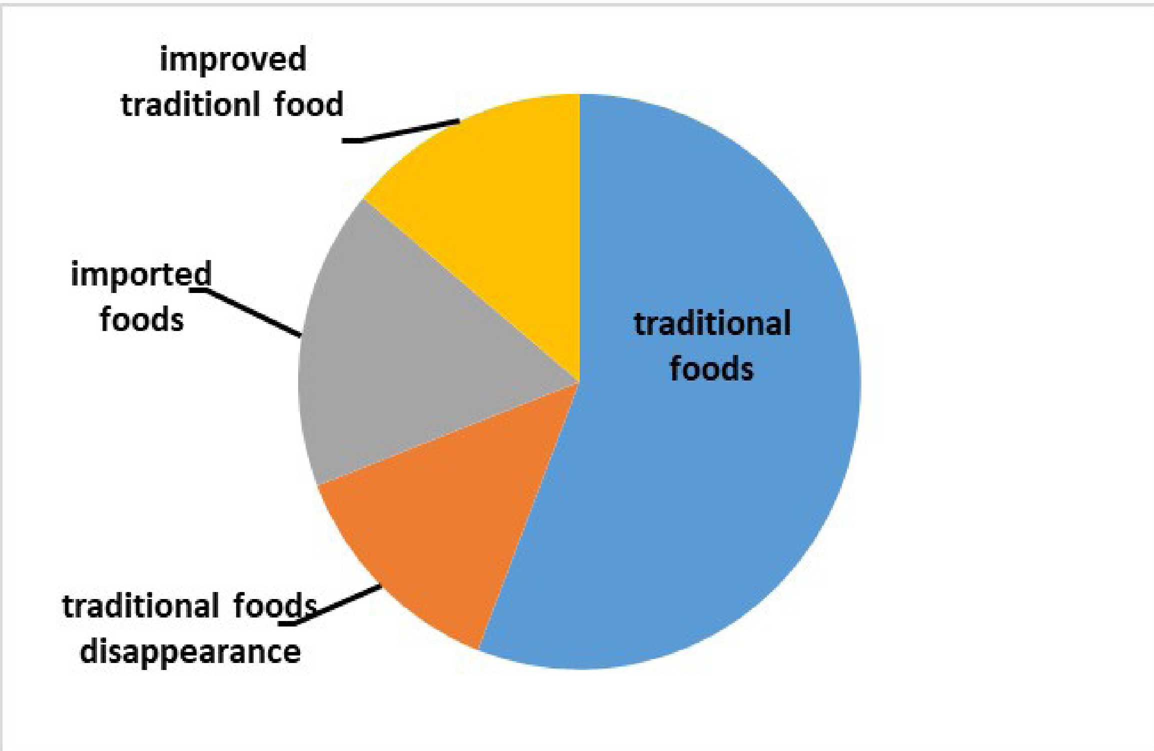

Figure 2. representation of traditional foods, improved traditional foods, and imported foods

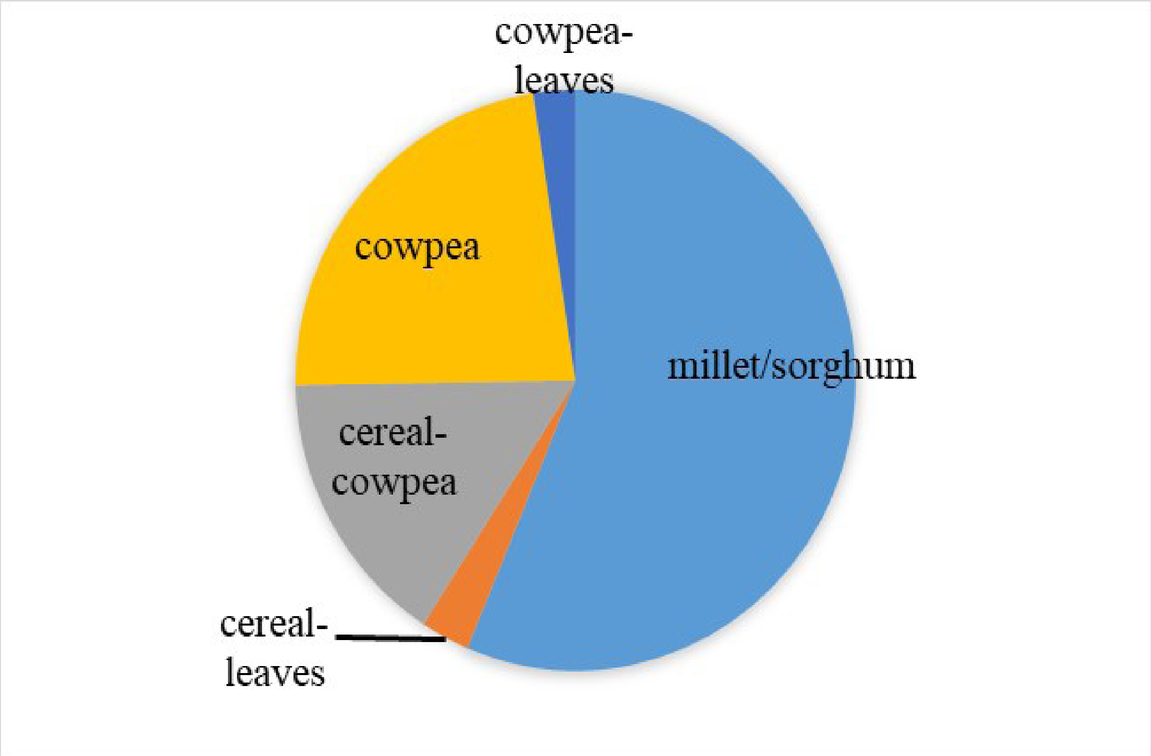

Figure 3. representation of common foods

3.2.3.1 Common foods

Commonly consumed foods were poorly represented among the foods inventoried. These foods are among others *banigula*, cowpea_cookie, porridge, *dolo, foura, pancake, gnon, gonre, guelbom, samsa, tô, wesla, zomparga, bassi, cowpea_millet, cowpea_sorghum, cowpea-wesla, mugdugu*. Among common dishes (Figure 3), cereal-based foods also represent 56%, cowpea-based foods 23%, and mixed foods 21% (cereal-cowpea, cowpea-leaves and cereal leave food). The result is a low representation of mixed foods and high consumption of simple cereal-based foods.

3.2.3.2 Occasional foods

Figure 4 shows foods consumed during the rainy season, the harvest season, the hunger season, and during the festive cited by participants.

Cereal-based dishes are the most cited among these dishes. The festive foods are classified into drinks (*zomkom, dolo bécé*), main food (*banigula, zabi, cowpea sauce*), and snacks (*pancakes). The foods tô, wesla, zoomparga, pigga, cowpea_millet, cowpea_rice, cowpea_wesla, wesla_leaves, bengnéton, bengyissa, babenda, berrense sagbo*, were cited as foods consumed during field work or the rainy season. The foods cowpea_cookie, gonré, tô, bengnéwesla, cowpea_millet, cowpea_leaves, bengyissa, coumwesla, zomparga, dolo, and kavadi were cited as foods consumed during the harvest. Cowpea_cookie, babenda, zomparga, and wesla were cited as foods eaten during the welding period

3.2.3.3 Food consumed by vulnerable groups

The food consumed by the vulnerable groups is mostly simple cereal-based food. Figure 5 shows the proportions of food types according to the raw material used by children, pregnant women, breastfeeding women, patients, and elderly people.
The proportion of legume (cowpea) foods was lower than cereals foods. A few cereal and legume foods were cited as specific to children. The foods most eaten by children are: porridge, *mugdugou, samsa, benga*, and mild *tô*. The food most eaten by the elderly are: *tô, dolo, gonré, wesla, wesla leaf, benga, kalbenga banigula* and *zomkom*. The food most consumed by the patient are porridge, *tô_ sauce_potash*, potash

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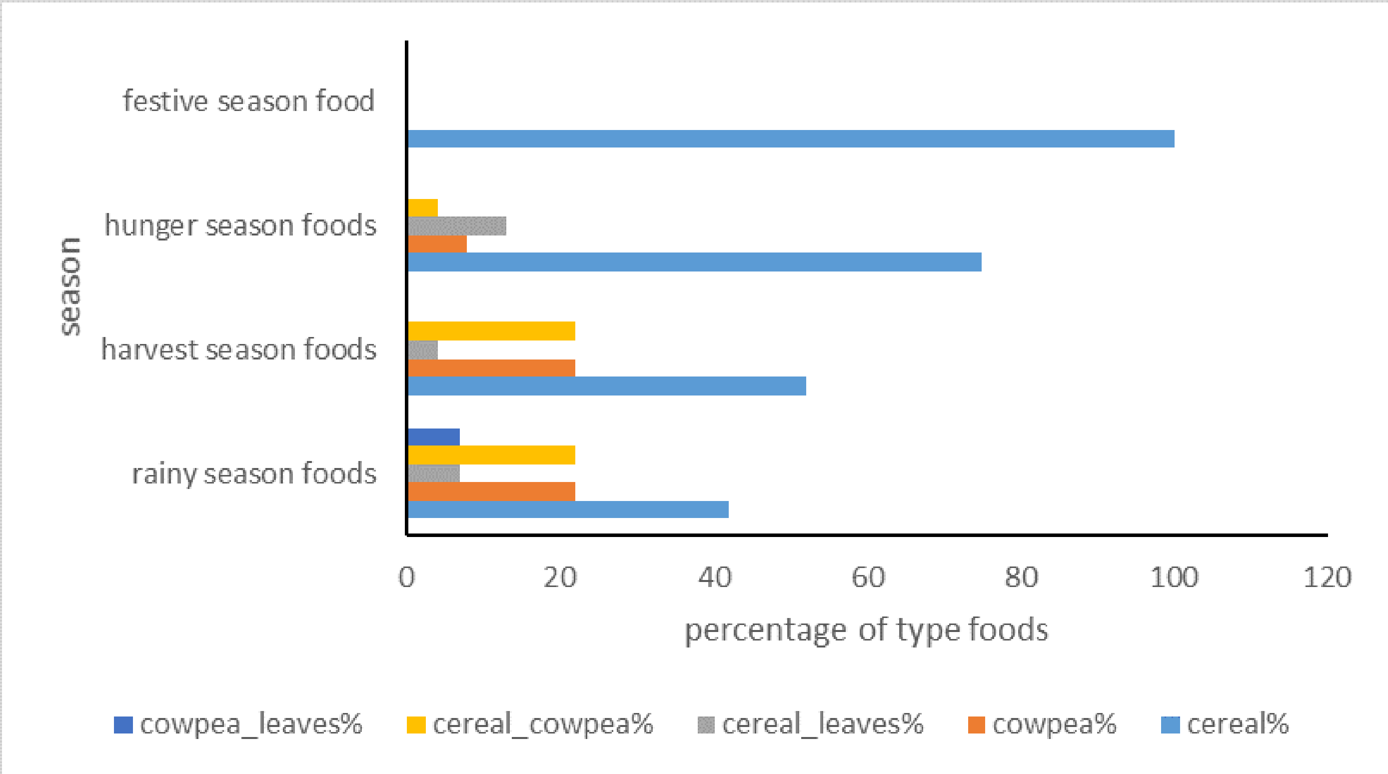

Figure 4. representation of the occasional foods

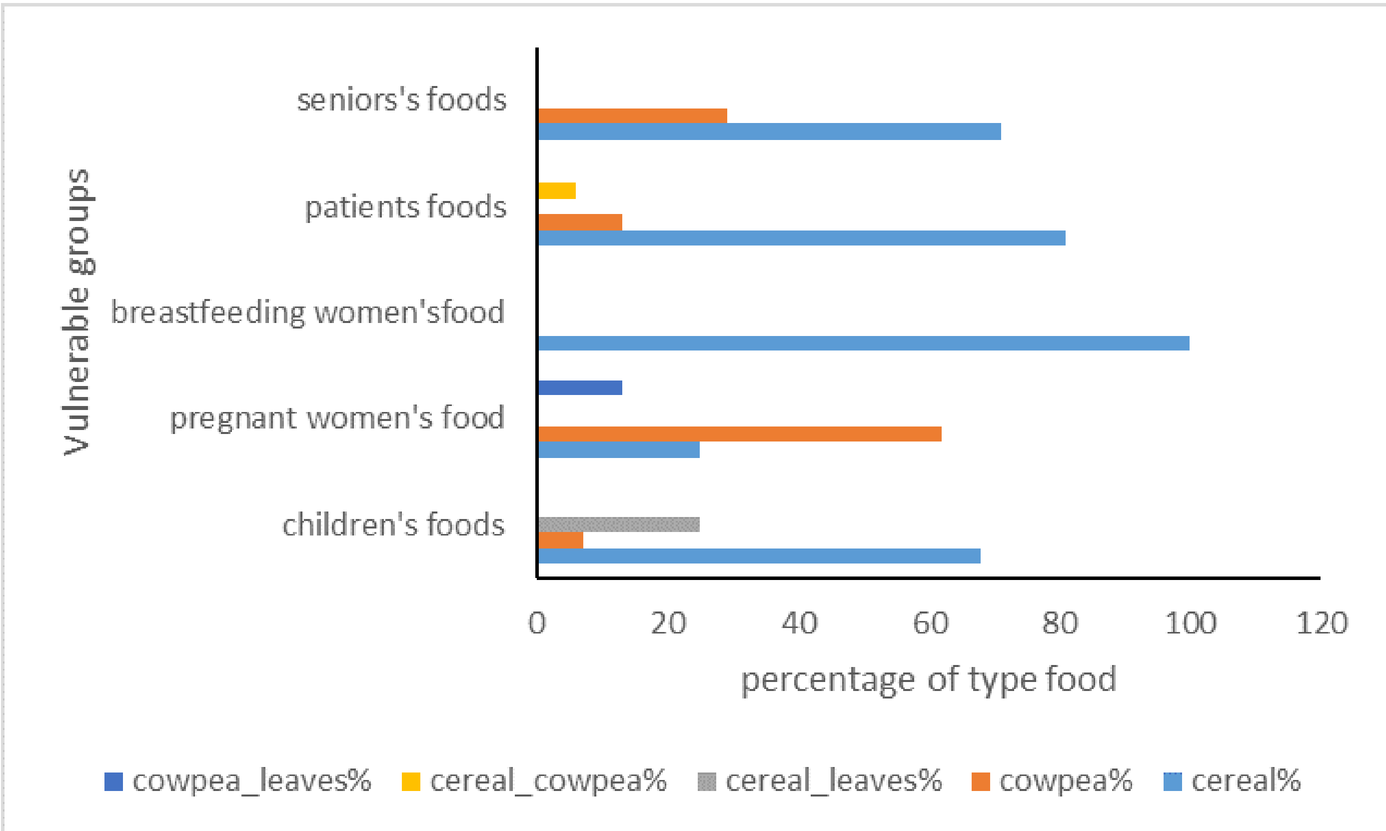

Figure 5. representation of vulnerable group's food

porridge, *wesla_feuille, wesla*, and *kalbenga*.

Most participants spoke of the non-specificity of the food for vulnerable groups. However, a few mentioned some specificity of the food for vulnerable groups. Indeed, enriched porridge for children, *kalbenga* used to treat respiratory illnesses, *Pog-rogdo-benré* porridge for post-partum women, gonré, benyissa for pregnant women.

Figure 6 presents the proportion of specific foods by gender and age group of the participants.

The food eaten by children was identified more by women in group G1 and that of pregnant women by women in groups G2 and G3. Food eaten by the patients was mostly mentioned by the men in group G3 and by the elderly by the men in group G1. Food consumed by postpartum women was cited only rarely.

4. Discussions

Simple cereal-based foods are the most common and account for 50% of traditional foods. Cowpea-based foods represent 18% and mixed foods represent 32%.

Cowpea is sold for family expenses rather than consumed. Studies have shown that cowpeas are grown for commercial purposes while sorghum and millet are grown for household consumption. households practice two cropping systems: a cash crop intended for the household's monetary needs, of which cowpea is a part, and a food crop intended for food needs, of which millet and sorghum are also part. (Bamba and Ouedraogo, 2014). Of the cereal dishes, 64% are millet-based and 36% sorghum-based. Millet and sorghum are used sometimes to prepare the same dishes. In addition to these common foods, millet is more suitable for preparation. Millet and sorghum-based dishes are widely eaten because both of these cereals are available, accessible, and easy to prepare, and are part of the region's eating habits. The high proportion of millet and sorghum-based foods cited by adults (G2) and youth (G3) compared to the old (G1) shows that there are new foods that were not known by the older generation. However, the proportion of cowpea-based dishes cited by the older generation compared to adults and children shows that there is

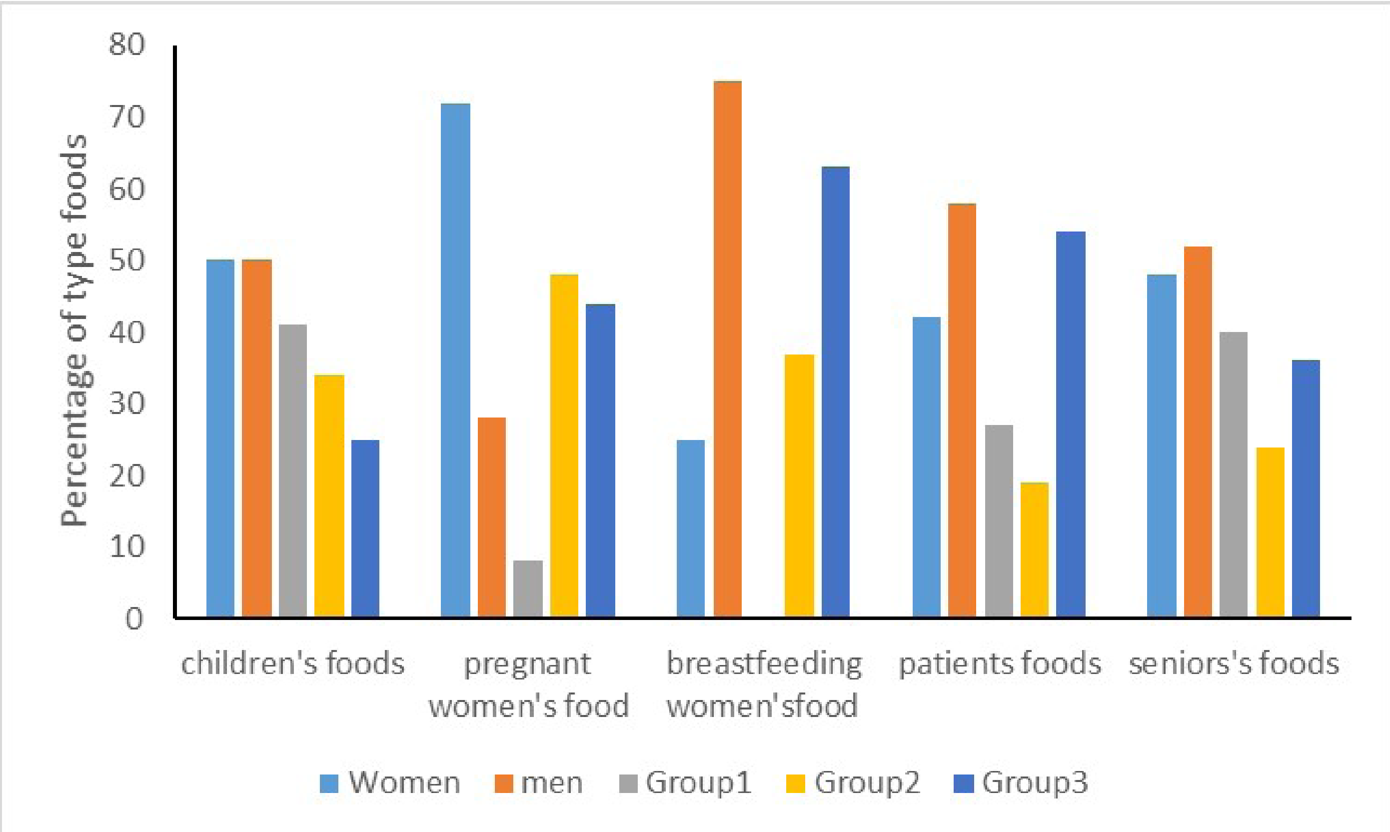

Figure 6. representation of specific foods by gender and age group

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a disappearance of certain dishes that the new generation no longer consumes. The abandonment of certain cowpea-based dishes composite dishes could be explained by the laboriousness of the processes, the cooking time resulting in an intense demand for energy while wood is difficult to obtain, the insufficiency of cowpea, the high cost of cowpea, and ingredients. Some cowpea-based dishes, such as *zabi, bengfale, malguemnore*, and *toubani*, are difficult to cook and took a lot of time. First, the cowpea must be soaked and shelled. The cowpea flour must be rolled before the lumps are obtained for the preparation of *zabi*.

Women in group G2 between the ages of 35 and 50 cited more cowpea foods than women in group G3 between the ages of 15 and 35 because they are generally responsible for meals and are more experienced.

Composite cereal and legume foods are more important than composite cereal and leaf foods, which in turn are more important than composite cowpea and leaves foods. These last two foods are little known by the new generation. They are also disappearing. Simple cowpea foods are less consumed in households because of their flatulence. Studies have shown the presence of anti-nutritional factors, such as protease inhibitors, lectin, phytic acid, tannin, and indigestible compounds among others induce flatulence (Madodé and al., 2013).

Of the known millet, sorghum, and cowpea-based foods cited by the focus group, nearly 80% are traditional foods, of which nearly 45% are endangered, and nearly 20% are new foods (improved traditional foods and imported foods). There are 46 traditional foods and tô is the food most consumed in all households. These similar results were found by other studies which revealed that tô represents 80.45% of the foods consumed in households in Burkina Faso((ENIAM, 2009) (Konkobo and al., 2002)). Another study also revealed that the percentages of children who consume *tô* and porridge of all cereals combined in some cities and villages of Burkina Faso are around 74.6% and 75.9% (Hama-Ba and al, 2019). The cause of the disappearance of the *banigula* was given by the G3 group of women from Lebda, stating: With the arrival of rice, people have abandoned *banigula*. The household that continues to prepare *banigula* is perceived as poor by other households.

Other studies identified new foods similar to those identified by the focus groups. These are improved traditional products ready for use in the cities (flour, semolina, porridge lumps, *deguè*, pre-cooked couscous, infant flours) and new products (bread, cookies, cakes, etc.) (Songre-Ouattara and al, 2015). The *dèguè* is a food imported from some countries bordering Burkina Faso (Tchekessi and al., 2014). It is obtained from cow's milk or fermented milk powder mixed with cereal flour pellets (Tchekessi and al., 2014). These new foods are illustrated by the following passage, by the men of the G3 group of Boussouma: *we notice the entrance of foods like dèguè, soybean brochette, boiled cabbage, salad, improved babenda which is not like the old food called zidparga or zizangsinga.*

In Benin in the past, *dèguè* was consumed during religious holidays among Muslims. For example, during the break of Lent or during the feast of Tabaski (Tchekessi and al., 2014).

The *tô* or cereal paste potash the potash porridge and the *kalbenga* (cowpea porridge) are specific food used in the tradition for the care of respiratory diseases (bronchitis, cough). These foods were mentioned by the women of G3 Lebda in the following passage: *If someone is sick, they cooked miltô with potassium sauce or porridge. To treat respiratory illnesses, we prepare millet porridge or kalbenga, which is also a cowpea-based porridge. If one has the means one can make fish or meat soup, leaves balls of kinlebdo or wild obergine to give him the taste of food.*

Among the dishes consumed by children, *mugdugu* and enriched porridge are composite dishes. Fortified porridge is known but very rarely consumed by children according to the statement of focus member. As a result, the specific foods represented 15.8% of the total foods generally consumed by the target groups. This proportion was very low. Seasonality is recognized as a key element of food availability in many developing countries (Savy and al., 2006). Cereal and leaves foods are more common during the growing and harvesting season than during the lean season. However, simple foods are the most consumed, even though households have the capacity to consume mixed foods.

The consumption of simple foods is a matter of dietary habits related to the socio-cultural context. The lean season, during which households have difficulty meeting their food needs, occurs during the rainy season until the harvest. (UNICEF, 2015). It corresponds to the period of crop depletion and is severe in areas where people depend on the annual harvest of the staple crop after only one year. In addition to the depletion of grain stocks, this period is also characterized by intense agricultural work ((Benefice and Cames, 1999) (Brun and al., 1981)). The food eaten during this period is cereal-based energy food (tô, couscous).

The men in Lebda's G2 group stated the following during the discussion: "*During the rainy season, we consume naturally the tô, the zomparga, the cowpea bouilie simple or mixed with leaves (kinlebdo), the couscous with shea butter*".

Also, a compound food far is consumed by the *babenda*. It is an old food generally consumed at the time of the soudure periods, when there was not enough cereal to support the needs of the families until the harvests (Tarnagda and al., 2018).

During festivals, food in the form of drinks (*dolo* and *zomkom*) and resistance dishes (*banigula, zabi, bohanbola (baska*), and *benga sauce (zambédé*) are consumed. The pancakes are eaten during Muslim and traditional funerals. *Zom-koom* is a non-alcoholic drink made from millet or sorghum. As for the *dolo*, it is alcoholic. It is called *becé* if the raw material used for its preparation is millet. They are much appreciated by the rural population and play an important role in Burkinabe culture. They are very attached to the tradition. *Zomkom* is considered a welcome drink and is consumed during religious ceremonies (baptism, marriage, funerals, doua). *Dolo* is consumed during traditional ceremonies (funerals, *Baska*, Christian feast). Its consumption is forbidden by the Muslim religion. The pancakes are prepared with oil in aluminium or clay pots. These foods were mentioned by the G2 group of Boussouma women in the following passage:" banigula is prepared during the *kidou* festival and is a real treat. Also we prepare the following dishe: zomkom, rice, meat, macaroni, *dolo*, sweets, *tô*, *wesla* of millet".

Other types of cereal-based drinks have been encountered in other African countries. These include pito in Ghana, doro in Zimbabwe, bouza in Egypt, kunun-zaki in Nigeria, and mougoudji in Mali. (Olasupo and al., 1997; Sawadogo-Lingani, 2010; Dje and al., 2008).

The consumption of simple cowpea foods could be encouraged in households to improve the protein deficiencies of the population, especially those children who need protein for their growth. In addition to being an interesting food from a dietetic and nutritional point of view, some studies have associated regular consumption of legumes with various benefits such as better control of diabetes (Venn and Mann, 2004), a decrease in the risk of cardiovascular disease, prevention against obesity and a decrease in the risk of colorectal disease (Giovannucci and Willett, 1994), (Bazzano and al., 2001), (Kabagambe and al., 2005), (Michels and al., 2006) (Rémond and Walrand, 2017).

Studies have shown that legume consumption can optimize glycaemic control in the medium and long term by improving the effects of insulin (Sievenpiper et al, 2009; Ramdath et al, 2016).

The main existing programs for promoting cowpeas are based on farming practices like the cereal-legume association.

5. Conclusion

Millet and sorghum-based dishes are the most numerous and represent half of the known traditional dishes. Women and men between the ages of 35 and 50 are more aware of the usefulness of these dishes, especially in the commune of Lebda. Most of the compound and cowpea-based dishes are abandoned and little consumed. These can be promoted in households to avoid protein deficiencies in the diet of children and recommended in the diet of people suffering from diabetes and high blood pressure.

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.

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Ethical considerations

The study was conducted under the free and informed verbal consent of the participants after a brief explanation of the purpose of the study. The confidentiality of the study subjects was ensured. We ensured that the participants ensured that the results of the study would remain (UNESCO, 2021)anonymous and would be used only for the purpose of this study.

Appendix

Appendix 1 and Appendix 2 show simple millet/sorghum dishes and simple cowpea dishes.

Zoom-parga

Zoom-Koom

Mugdugu

Bassi

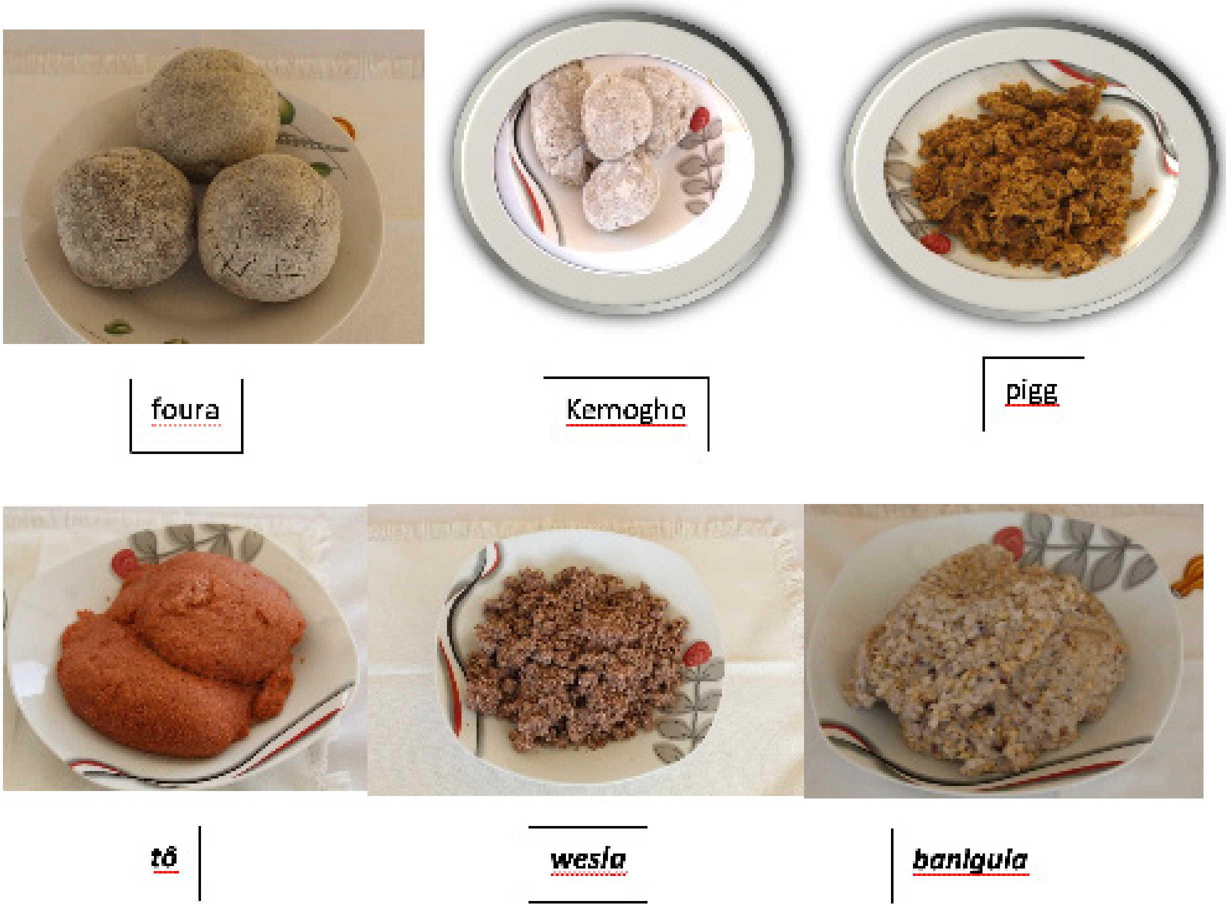
Pog-rogdo-benré

porridge

tô

pancake

Guelbom/kidamai



Appendix1. simple millet/sorghum foods

Appendix 2. simple millet/sorghum foods

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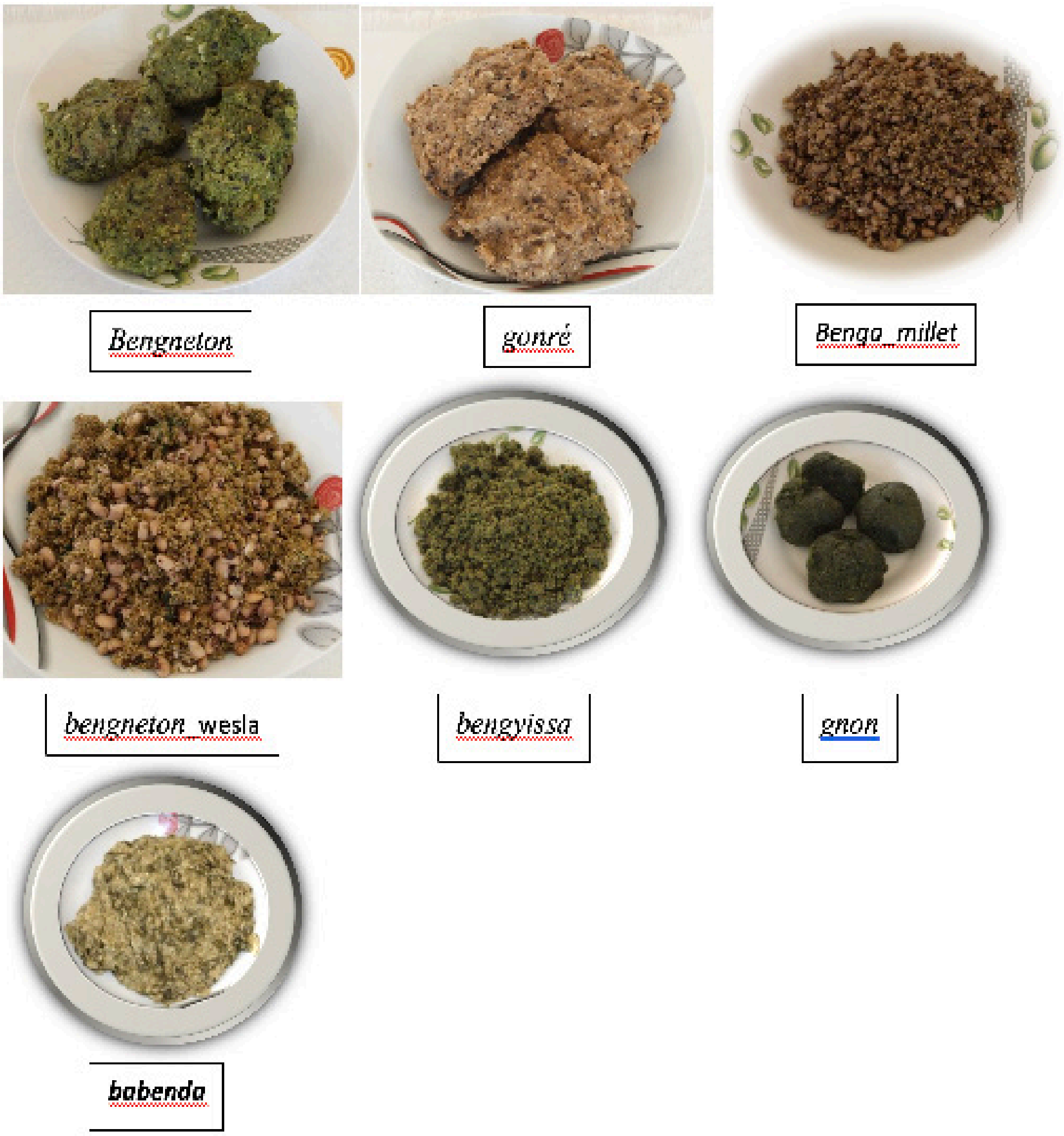
Appendix 3 shows the millet/sorghum+legume, millet/sorghum+leaves and cowpea+leaves dishes.



Appendix3. composite food

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Historical drought and flooding on the Amazon River

A recent study conducted by researchers from the University of Arkansas (U of A) has examined historical patterns of drought and flooding in the Amazon River Basin. The study reveals that despite a notable increase in severe flooding events, the extreme floods and droughts observed over the last 40 years might not have surpassed the natural hydroclimatic variability that the region has experienced.

The Amazon River Basin has witnessed more frequent instances of extreme floods and severe droughts in the past four decades, with a significant number of the most extreme floods occurring within the last 14 years. The research attributes these occurrences to a combination of factors, including natural climate fluctuations, deforestation, and human-induced climate change.

Published by the American Meteorological Society, the study utilized tree-ring analysis and historical records to reconstruct past rainfall in the Amazon. The researchers found evidence that suggests floods in the years 1859 and 1892 might have been as severe as recent ones. Notably, the population residing in flood-prone areas has significantly increased since those earlier periods, raising concerns about the socio-economic impact of extreme events on vulnerable communities.

The study underscores the importance of understanding historical flooding patterns in anticipating and mitigating future environmental and socioeconomic consequences. The researchers point out that the severity of past flooding events provides context for potential future devastation, particularly given the dense population now at risk. The study utilized tree-ring collections from the Rio Paru, a tributary of the Amazon, and involved collaboration with environmental scientists in Brazil to examine the age, growth rate, history, and climate sensitivity of the region's tropical hardwood trees.

Journal Reference:

Daniela Granato-Souza, David W. Stahle. **Drought and flood extremes on the Amazon River and in northeast Brazil**, 1790-1900. Journal of Climate, 2023; 1 DOI: 10.1175/JCLI-D-23-0146.1

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2023 Global Heat Wave: July brought the hottest three weeks observed so far

A study by the Karlsruhe Institute of Technology (KIT) reveals that the first three weeks of July 2023 marked the hottest global period on record. In Germany during the summer of 2023, twice as many people experienced daily temperatures of 35 degrees Celsius or higher compared to the average from 1980 to 1999. KIT's Center for Disaster Management and Risk Reduction Technology (CEDIM) found that Italy had the highest population exposure to heat in Europe.

The study analyzed several heatwaves across the northern hemisphere in 2023, resulting in record-breaking temperatures in various regions. Global mean ocean surface temperatures in June 2023 reached unprecedented levels, and the Earth's surface recorded its warmest June since 1850. The first three weeks of July 2023 were globally the hottest ever recorded, with a daily high of 17.08 degrees Celsius on July 6.

Persistent high-pressure areas in July 2023 contributed to the heatwaves by influencing airflow and air mass transport. The study also assessed population exposure to heat, finding that Germany experienced a significant increase in people exposed to temperatures over 25 and 35 degrees Celsius. Italy faced the most severe heat, with record temperatures exceeding 40 degrees Celsius and a substantial rise in exposed individuals.

To address health concerns from heat exposure, measures were taken globally, including the installation of public wells and water dispenser systems. Italy, in particular, witnessed a notable increase in such systems to mitigate the effects of extreme heat on public health.

Original Publication (Open Access)

Andreas Schäfer, Bernhard Mühr, Florian Kaiser, Denise Böhnke, Susanna Mohr, Michael Kunz: **Untersuchung der globalen Hitzewelle im Jahr 2023.** Report No.1. CEDIM Forensic Disaster Analysis (FDA) Group, Karlsruhe Institute of Technology (KIT), 2023. DOI: 10.5445/IR/1000161235 https://publikationen.bibliothek.kit.edu/1000161235

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Could microplastics in soil introduce drug-resistant superbugs to the food supply?

Plastics play a crucial role in modern agriculture, used in various forms like mulch, pipes, and packaging. A review by researchers from the University of Illinois Urbana-Champaign reveals that microplastics and nanoplastics, resulting from the breakdown of plastics, have become widespread in agricultural soils. These plastics can contribute to the development of antibiotic-resistant bacteria that could enter the food supply chain.

Microplastics attract chemical substances and microorganisms, leading to higher concentrations of chemicals like pesticides and heavy metals. Bacteria gather on microplastics, forming biofilms that can increase their resistance to antibiotics. Genetic mechanisms developed by bacteria to cope with stress can inadvertently make them more resistant to antimicrobials.

While gene transfer between bacteria on microplastics has been observed in water environments, its occurrence in agricultural soil remains less explored. The researchers are conducting laboratory studies to document gene transfer in soil. Nanoplastics and antibiotic-resistant bacteria could potentially enter plants through their roots, making them hard to remove from the food chain.

As microplastics persist in the environment for long periods, understanding their impact on soil and the food system is crucial. The study aims to raise awareness about this issue and encourage the exploration of biodegradable plastic alternatives.

Journal Reference:

Jayashree Nath, Jayita De, Shantanu Sur, Pratik Banerjee. **Interaction of Microbes with Microplastics and Nanoplastics in the Agroecosystems—Impact on Antimicrobial Resistance.** Pathogens, 2023; 12 (7): 888 DOI: 10.3390/pathogens12070888

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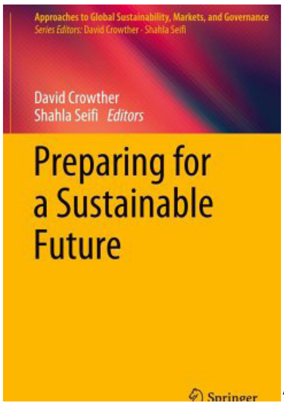

Preparing for a Sustainable Future

A review by Diana Ismael

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The term "sustainability" holds immense significance in today's world, permeating various domains such as academia, politics, business, media, and public discourse. It's universally recognized as the paramount concern for the planet's future and its inhabitants. While the concept is intricate and subject to ongoing debates about its definition and attainability, the indisputable fact remains that Earth's finite resources cannot be replaced once used. Much attention is currently devoted to environmental issues, especially climate change and its repercussions, resulting in discussions primarily focused on mitigation.

Sustainability encompasses economic, environmental, and social aspects, with the social dimension potentially exerting the most profound influence on achieving sustainability. This book, within 11 chapters, uniquely concentrates on the social aspects and how individuals can adjust their lifestyles to align with sustainability goals, without neglecting the other dimensions. Moreover, the book aims to analyze the necessary shifts in personal, corporate, and institutional behavior required to advance sustainability objectives. It delves into global instances of addressing these issues, aiming to share best practices and enhance discussions on our journey toward sustainability. The international collaboration behind this book draws from diverse perspectives, offering innovative viewpoints that often elude researchers, politicians, and the media.

The book starts with the potentiality of digital learning practices in bringing sustainable development to a sustainable education system. Amid the global COVID-19 pandemic, Digital Learning emerged as the sole dependable substitute for traditional in-person education. Educational institutions worldwide transitioned their courses to e-learning formats, necessitating the assurance of digital learning's sustainability. This chapter introduces a proposed theoretical model, built upon the Technology Acceptance Model (TAM), to assess e-learning acceptability. The model's application at Mauritius' Université des Mascareignes demonstrates the positive influence of online learning platforms on student acceptance, learning outcomes, and academic performance. The model correlates success factors with diverse measures of achievement within this evolving educational landscape.

It was recently discussed that intrapreneurship plays a vital role in ensuring an organization's long-term viability. In its second chapter, the book delves into the definitions, aspects, and significance of intrapreneurship, shedding light on its potential as a potent strategy for maintaining organizational sustainability. Intrapreneurship offers a means for organizations to effectively navigate both internal and external shifts, fostering innovation and rejuvenating their operations. It also serves as a valuable approach to steer innovation within various companies, effectively addressing multifaceted challenges. Intrapreneurship serves as a dynamic tool to reinvigorate, modernize, innovate, cultivate new skills, establish fresh ventures, enhance products, optimize resource utilization, tap into new prospects, and access unexplored markets for organizations. Essentially, the adept application of this approach is recognized as a pivotal driver for ensuring the organization's lasting sustainability.

Certainly, media regulation establishes significant rights and freedoms, including journalistic independence and the right to express and access information. The Independent Broadcasting Authority (IBA) (Amendment) Act of Mauritius, ratified on November 30, 2021, introduces specific journalistic limitations that sparked public outrage and received extensive coverage in national newspapers. The contentious aspect of this amendment is the considerable authority granted to the IBA, the regulatory body for media in Mauritius. Therefore, this chapter intends to critically assess the legal framework governing media in Mauritius, focusing on the powers of the Mauritian IBA and the key modifications introduced by the recent amendments to the IBA Act. To achieve this goal, the research will utilize the black letter approach and conduct a comparative analysis of media-related legal regulations in Mauritius and South Africa.

While sustainability is a widely embraced yet intricate concept, its practical implementation presents challenges. Despite numerous initiatives and discussions on integrating sustainability into daily lives and business practices, many individuals and institutions remain hesitant to adopt it. However, social enterprises emerge as a positive force in this scenario, bridging the gap between non-profit organizations and profit-driven businesses. This chapter focuses on the example of Greenstraw, a social enterprise that encompasses a lifestyle store, cafe, community and coworking space, and a foundation. Greenstraw is dedicated to promoting both environmental and social sustainability in its operations. It serves as a successful illustration of a social enterprise driven by sustainability goals. The enterprise effectively balances competitive product offerings, all sourced, produced, and delivered in sustainable ways. The chapter applies Petit's Behavioral Drivers Model (2019) to analyze the impact of Greenstraw's approach and to provide insights for future actions.

Chapter five aims to explore how publicly listed companies in Mauritius perceive and communicate their commitment to environmental and biodiversity protection within the framework of sustainability reforms. It investigates whether these commitments are driven by practical or intrinsic values. The research uses content analysis of disclosures and discourse analysis of corporate commitment statements, focusing on firms listed on the Stock Exchange of Mauritius from 2008 to 2016. The findings show an increasing trend in environmental disclosures, with a shift towards more quantitative reporting. Companies tend to prioritize human-centered perspectives in their environmental disclosures. Although the launch of the Maurice Ile Durable (MID) project had limited impact, an increased MID levy on liquefied petroleum gas led to higher environmental disclosures. Thematic analysis highlights growing mentions of themes like "awareness campaigns," "carbon footprint," and "environmental policies" in annual reports. This chapter provides valuable insights into environment and biodiversity reporting in a developing economy and Small Island Developing States (SIDS).

The United Nations' Agenda 2030 and Sustainable Development Goals (SDGs) aim to address global challenges and foster a sustainable future. Higher Education Institutions (HEIs) have expanded their roles to include societal service and economic impact alongside education and research. This chapter focuses on how Université des Mascareignes (UdM), a young public HEI in Mauritius with a North-South partnership, implements SDG 4 (Quality Education). Using qualitative methods, the research involves interviews with top management and staff at UdM. The study identifies strategies employed across various aspects of the institution to achieve SDG 4. Despite its small size, UdM actively pursues SDG 4 through community engagement, accessibility enhancements, gender representation improvements, diverse course offerings, financial support, tailored learning for athletes, policy establishment, and more. Quality education is ensured through a balanced student experience, safe environment, feedback mechanisms, staff and student mobility, research projects, sustainability integration, quality assurance, technology-enabled learning, and vocational training.

In chapter seven, the authors aim to compare engagement levels between temporary and staff workers while exploring the impact of contractual relationships on workers' perceptions of organizational leadership. A survey involving 82 workers, with 63.4% from a temporary work company, was conducted. Staff workers reported having more transformational leaders and better leader performance evaluations. In contrast, temporary workers noted a higher prevalence of "laisser-faire" leaders. While work engagement didn't significantly differ, temporary workers exhibited greater energy expenditure, mental resilience, willingness to address challenges ("vigour"), and intense focus ("absorption") on work tasks. Conversely, effective workers displayed increased dedication involving high involvement, performance, and finding meaning in their professional activities.

Society's growing interest in sustainability has led to increased scrutiny of public entities' practices. Municipalities, crucial components of the public sector, play a pivotal role in citizens' lives by delivering essential services and addressing societal needs. This chapter centers on evaluating sustainability reporting practices among municipalities in northern Portugal. It aims to assess the extent of information disclosure and understand the factors influencing disclosure. Municipalities significantly impact society, prompting a rise in demand for sustainability information. The chapter addresses a limited area of study, seeks to bridge this gap and assess the effectiveness of sustainability reporting on the websites of northern Portuguese municipalities. Moreover, 86 municipalities were examined, quantifying their disclosure levels while investigating potential explanatory factors. These factors encompass sociodemographic, socioeconomic, fiscal, and political considerations, all contributing to a disclosure index.

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School Citizens Assemblies (SCA) are initiatives that bring together students, experts, educators, and community members in a collaborative and co-creative process. This chapter highlights the aims of SCA to empower youth by facilitating collaborative efforts among schools, experts, and community stakeholders. Through a co-creative process of research, innovation, and action, SCAs intend to address intricate challenges. Effective problem-solving necessitates collective endeavors that embrace creativity, inclusivity, sustainability, responsibility, and compassion. Collaborative work allows a comprehensive understanding of complex issues, encouraging the mobilization of knowledge and skills for viable solutions. The SCA approach strives to achieve this by fostering divergent thinking and unpacking various perspectives and by creating spaces for productive convergence where effective actions can be developed, tested, and assessed. By challenging limiting relational structures and biases, SCAs aim to facilitate equitable and inclusive interactions. This approach fills a gap in the educational system by promoting innovative teaching, learning, and community engagement. SCAs encourage diverse stakeholders to collaborate on tackling local and global challenges, fostering individual, organizational, and environmental growth and prosperity.

The tenth chapter introduces a comprehensive statistical model applicable on a global scale, designed to assess corporate governance in intricate organizations, accounting for diverse factors like contingency and paradox. The chapter’s practical contribution is the Diocesan Corporate Governance Index (DCGI), a new ecclesiastical corporate governance proposal. This index expands the conventional ecclesiastical governance model, which centers on conformity, mechanism, and performance, by adding a fourth dimension—disclosure. The DCGI prompts discussions on implementing such a model while excluding considerations of feasibility and execution.

Education can be well-thought-out to be the key to a successful future of any nation. Within the pandemic situations, where the whole world is suffering, various governments have kneeled down due to economic and health deteriorating features, the education system has still remained a priority for many of them. The last chapter emphasizes the significance of leadership style, work quality, satisfaction, and performance in this context. It aims to explore the relationship between the New Facet Leadership Style, quality of work life, satisfaction, and performance in Mauritius' secondary schools. The discussion in this chapter contributes to the understanding of work quality, job satisfaction, and the New Facet Leadership Style's impact. It paves the way for future research on these aspects at national and international levels.

The book emerges from the Social Responsibility Research Network's tradition of holistic exploration, where interdisciplinary research is interconnected and pertinent to business. With contributions from the network's recent conference, the book showcases various approaches and effects, providing fresh insights into the critical concern of our collective future. I highly advise reading this book for a better knowledge of how different aspects affect out more sustainable future.

About the author:

Diana Ismael is a sensory specialist with a PhD in Food and Sensory Science/Consumer Behavior from Kassel University, Germany. Her research focuses on understanding the intention-behaviour gap in organic food consumption. Currently, she works as the Managing Editor at the Future of Food Journal: Journal on Food, Agriculture & Society.

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