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A letter from Head of Editorial Board

Why does our Future of Food Journal need a strong Editorial Board?

Thoughts about the role of an editorial board and selection for editorial board members

Prof. Dr. Dr. hc. mult. Angelika Ploeger, Head of the Editorial Board FoFJ

Our Future of Food Journal (FoFJ) exists since 2013 and – as the title expresses – publish scientific papers in the research fields of environment and agriculture, the nutritional value of food and food consumption pattern, food safety and food sovereignty linked to social changes and social empowerment. We encourage especially young scientists working in inter- or transdisciplinary projects to publish their results because we can offer a multidisciplinary Journal and the "golden standard" for open access publication which means without a publication or reading fee. The Journal is supported VDW (Association of German Scientists) as well as the Department of Specialized Partnerships in Sustainable Food Systems and Food Sovereignty at Kassel University, Germany.

Of course, since 2013 the situation looking especially at open access Journals has changed a lot. The competition between Journals increased so that some of the publishers manage a wide range of scientific fields such as Springer, MDPI, Elsevier (but mostly with a very specific profile in the different Journals). In contrast, the Future of Food Journal aims to support scientific publications linking social science with natural science in environmental, agricultural or food. The Journal is acknowledged by a lot of publishers and valued with H 4. This H-index for example addresses the productivity and citation impact of a paper but this way of "ranking" is criticized by some scientists for an invalidate comparison not only across disciplines but even within different fields of research of one discipline. To achieve a high quality of papers although

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looking for a wide range of interest areas, the Editorial Board plays a very important role. The review board members are essentially ambassadors for the journal. The Peer review gives research "a stamp of approval", but the reviews themselves can be flawed. This might be serious not only for the writer but also for the journal, and journal reader. For our Future of Food Editorial Board, we would like to receive credible feedback from experts of the above-mentioned fields throughout the publishing process to ensure the journal continues to develop and present relevant research. An editorial board member may even provide occasional content in the form of short articles or editorials for our Journal. We encourage the board members and reviewers to identify topics that are of importance to the community which our journal serves. With this issue of FoFJ, we acknowledge the work of our Editorial board members, some serving us now for 7 years. We thank for their valuable time supporting the review and publishing process or the discussions with us about upcoming topics in the different areas of research. Generally speaking, it is helpful to rotate board members regularly to ensure the journal keeps pace with the breadth and diversity represented by the subject community. So, we decided to renew our board based on parameters such as scientific fields which we need for review and experience in reviewing, credibility and overall commitment to the FoFJ, balance in gender and age.

From 2021 we will provide a list of possible reviewers for scientists who would like to publish with us, identifying the areas of expertise so that they can choose not only reviewers they know but indicate researchers from the list.

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Effects of salicylic acid, putrescine and moringa leaf extract application on storability, quality attributes and bioactive compounds of plum cv. 'Golden Japan'

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Keywords

Plum, golden japan, salicylic acid, moringa leaf extract, cold storage, phenolics, carotenoids, flavonoids, antioxidant activity

Background: Plum fruits constitute a good source of natural antioxidant substances. Particularly, plums contain large amounts of phenolic compounds and flavonoids that have natural antioxidant activity which is useful to human health. The study aimed to evaluate the effects of foliar sprays with salicylic acid (SA), putrescine (PUT) and moringa leaf extract (MLE) on the fruit quality attributes and bioactive compounds of 'Golden Japan' plums under cold storage conditions. Plum trees were sprayed twice; at fruit set stage and one month later during seasons 2018 and 2019 by combinations from SA (3 and 4 mmol/L), PUT (3 and 4 mmol/L) and MLE (5 and 10%), as well as distilled water (control). Fruits were harvested at maturity stage and stored at 0°C with relative humidity 85-90% for eight weeks.

Results: With advance storage period, fruit weight loss, total soluble solids (TSS), total carotenoids content (TCC) and total phenolics content (TPC) increased significantly while the fruit firmness, lightness (L*), hue angle (h°) of colour, titratable acidity (TA), total flavonoids content (TFC) and antioxidant activity (AA) decreased significantly ($P < 0.05$). Statistically significant differences were observed between different treatments in maintenance on all measured parameters when compared to control. At the same time, a combined SA at 3mmol/ L, PUT at 4 3mmol/ L and MLE at 10% treatment was found to be more effective than other treatments in decreasing the weight loss, softening and maintaining titratable acidity, total carotenoids, total phenolics, total flavonoids and antioxidant activity in plum fruits during storage at 0 °C.

Conclusion: It was concluded that preharvest treatment of plum fruits with salicylic acid, putrescine and moringa leaf extract was effective in delaying the ripening processes and can be used commercially to extend the storage life of postharvest plum fruits with acceptable fruit quality.

1. Introduction

Golden Japan plum cultivar (Prunus salicina Lindl.) is member of the Rosaceae family belonging to the Japanese species, which mainly consumed fresh. Japanese plums have short postharvest life depending upon the cultivar and supply-chain conditions. The low-temperature storage at 0 °C is recommended for

extending the storage and shelf life of plums facilitating prolonged marketability period and long-distance transport (Singh and Singh, 2012). Excessive softening of fruit flesh is the basic factor shortening storage time, shelf life and decreasing the market value of the fruit. Preservation of fruit firmness provides the preservation of taste, flavour and fruit texture and consequently increases plum consumption (Crisosto et al., 2004). There are several methods to prolong storage life and to preserve the quality of horticultural crops. One of them is to apply plant growth regulators and polyamines before and after harvest (Kucuker and Ozturk 2014; Davarynejad et al., (2015).

Salicylic Acid (SA) is an endogenous plant growth regulator and it has been found to generate a wide range of metabolic and physiological responses in plants thereby affecting their growth and development. SA as a natural and safe phenolic compound exhibits a high potential in controlling postharvest losses of horticultural crops (Asghari and Aghdam 2010). Preharvest application of SA has been shown to be effective in enhancing resistance to pathogens, controlling postharvest decay and a remarkably maintaining the fruit quality during postharvest storage life of peach (Wang et al., 2006), sweet cherry (Xu and Tian 2008), persimmon fruits (Khademi et al., 2012), plum (Davarynejad et al., 2015), nectarine (Bal 2016) and apple fruits (Aly et al., 2019).

Putrescine (PUT) is a polyamine, low molecular weight found in living organisms (Galston and Sawhney 1990). Many studies have shown that exogenously applied PUT affect fruit quality through some change in fruit firmness, weight loss, ethylene evolution, total soluble solids, titratable acids, reduced fruit deterioration and increased shelf life in many fruits (Martínez-Romero et al., 2002; Khan et al., 2008; Ba l.2012; Abbasi et al., 2019).

Moringa leaf extract (MLE) is a supplement or alternative to inorganic leaf fertilizer (Phiri 2010). It contains important minerals, proteins, vitamins, β carotene, amino acids and various phenolics that provide a rich and rare combination of zeatin with several flavonoid pigments (Siddhuraju and Becker 2003). So it is a good source of natural antioxidants (Jacob and Shenbagaraman 2011). Several studies pointed out that spraying moringa leaf extract increased the yield and percentage of marketable fruit and decreased the percentage of unmarketable fruits (Sheren and El-Amary 2015; Nasira et al., 2016; Thanaa et al., 2017).

This study aimed to evaluate the effects of preharvest treatment with salicylic acid, putrescine and moringa leaf extract on weight loss, fruit firmness, colour, total soluble solids, titratable acidity, total carotenoids, total flavonoid, total phenolic and total antioxidant activity of Japanese plums cv. Golden Japan under storage conditions at 0°C.

2. Materials and methods

This study was carried out during two successive seasons 2018 and 2019 on Ten-year-old plum (Prunus salicina Lindl.) cv. Golden Japan budded on Myrobalan plum (Prunus cerasifera) rootstock and planted at 5× 5 m in loamy clay soil under surface irrigation systems in a private orchard in Ashmoun, Monofia Governorate, Egypt. Fifteen trees uniform in vigour, trained on open vase a training system were chosen randomly as three trees/ treatment. Selected trees were sprayed twice; at fruit set stage (15th and 12th March in both seasons, respectively) and one month later during the years 2018 and 2019.

The treatments applied were:

T1: Control (Water only)
T2: 3 mmol/L SA+ 3 mmol/L PUT + 5 % MLE
T3: 3 mmol/L SA+ 4 mmol/L PUT +10% MLE
T4: 4 mmol/L SA+ 3 mmol/L PUT + 5% MLE
T5: 4 mmol/L SA+ 4 mmol/L PUT + 10%MLE

Preparation of moringa leaf extract

The aqueous extract of moringa leaves was prepared according to the method described by Thanaa et al., (2017), soaking 100 g of air-dried moringa leaves in 1 litre of water for 24 hours, then filtered and diluted with water to 5%, 10% and sprayed directly on the trees thoroughly sprayed till runoff (about 4-5 litre/ tree). Tween-20 at 0.01% was added as a surfactant.

Undamaged mature plum fruits, free from apparent pathogen infection, uniform in shape, weight and colour were picked separately from each treated group. Fruits were harvested in the first week of June during each study season. Samples (approximately 90 fruits) were collected from three trees per each treatment,

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then fruits were transported to the laboratory and packed in perforated carton boxes. Each treatment was packed in six boxes, and classified into three groups. The first group contained fruits for periodical determination of physical and chemical properties, the second group contained fruits for determination of weight loss and the third group contained fruits for determination of decay per cent. Fruits were stored at 0°C with relative humidity (RH) 85-90% for eight weeks. Assay of the stored fruits were determined at 2 weeks intervals, as follows:

Physical properties

Weight loss percentage: The difference between the initial weight of the fruits at the beginning of storage and that recorded at the date of sampling was translated as weight loss percentage and calculated as follows:

$$Weight\ loss\ \% = \frac{Weight\ at\ the\ date\ of\ sampling\ (g)}{Initial\ weight\ of\ the\ fruits\ (g)} x100$$

Fruit firmness (Lb\in2): fruit firmness was determined as Lb/in2 by using fruit pressure tester mod. FT 327 (3-27 Lbs).

Fruit color: Lightness (L*) and hue angle (h°) were estimated using Minolta Calorimeter (Minolta Co. Ltd.,Osaka, Japan) as described by Mc Gire (1992).

Decay percentage: The percentage of disordered fruits included all of the spoiled fruits from rots, fungus, bacterial and pathogens, results were assessed and the defects were calculated as follows:

$$Decay\ \% = \frac{No.\ of\ fruit\ decay}{No.\ of\ fruit\ at\ the\ beginning\ of\ storage} x100$$

Chemical properties

Total soluble solids (TSS): Percentage of TSS was determined in plum fruit juice using Digital refractometer PR32 (Atago Palete ATago.CO .LTD. Japan).

Titratable acidity (TA): Percentage of TA was determined by titrating the juice against 0.1 N sodium hydroxide using phenolphthalein indicator and expressed as a percentage of malic acid according to AOAC (2000).

Total carotenoids content (TCC): Carotenoids content of fruits was extracted by direct dipping of 10 gm of fruit pulp into a solution containing 40 ml acetone, 60 ml hexane and 0.1 g Mg Co3 and blended for 5 minutes. It was determined by colourimeter according to AOAC (2000). The TCC was expressed as mg /100 g extract.

Total flavonoids content (TFC): The TFC was measured by a colourimetric assay developed by Zhishen and others (1999). The absorbance of the mixture was determined at 510 nm versus a prepared water blank. Quercetin was used as the standard for the calibration curve. The TFC was expressed as mg quercetin equivalents (QE) /100 g extract.

Total phenolics content (TPC): TPC in the juice was determined using the Folin–Ciocalteu method (Meighani et al., 2014). Total phenolic content was expressed as mg gallic acid equivalent in 100 mL of juice (mg gallic acid /100 mL juice).

Antioxidant activity (AA): AA was assessed according to the method of Ismail and others (2009). In brief, 1 g of plum tissue was extracted with 10 ml methanol (85%). One ml of this extract was mixed with 2 ml of 0.15 mM DPPH (1,1-diphenyl-2- picrylhydrazyl) in methanol. The mixtures were shaken vigorously and left to stand for 30 min (under dark conditions). The control was prepared by adding 2ml of DPPH to 1ml methanol. Absorbance of the resulting solution was measured at 517 nm by a Cecil 2010 UV-visible spectrophotometer. The antioxidant activity is expressed in the form of the percentage of free radical scavenging.

Statistical analysis

A randomized complete block design was used for analysis of variance for comparison between the control and the others. All data were subjected to statistical analysis according to the procedures reported by Snedecor and Cochran (1990) and means were compared by Duncan's multiple range tests at the 5 % level of probability.

3. Results

Weight loss percentage

Figure 1 cleared that a gradual increase in weight loss

was shown towards the end of the storage period (8 weeks). Significant differences between regardless of all treatments. The lowest weight loss percentage (12.63 and 12.25%) was recorded by the mixture application of 3SA+ 4PUT+10MLE in two seasons, respectively. On the other hand, control fruits exhibited the highest weight loss value (16.97 and 14.81%) in the first and second seasons, respectively.

Fruit firmness

Data obtained regarding fruit firmness, presented in Figure 2 shows that firmness decreased with the progress of storage periods in both seasons. There

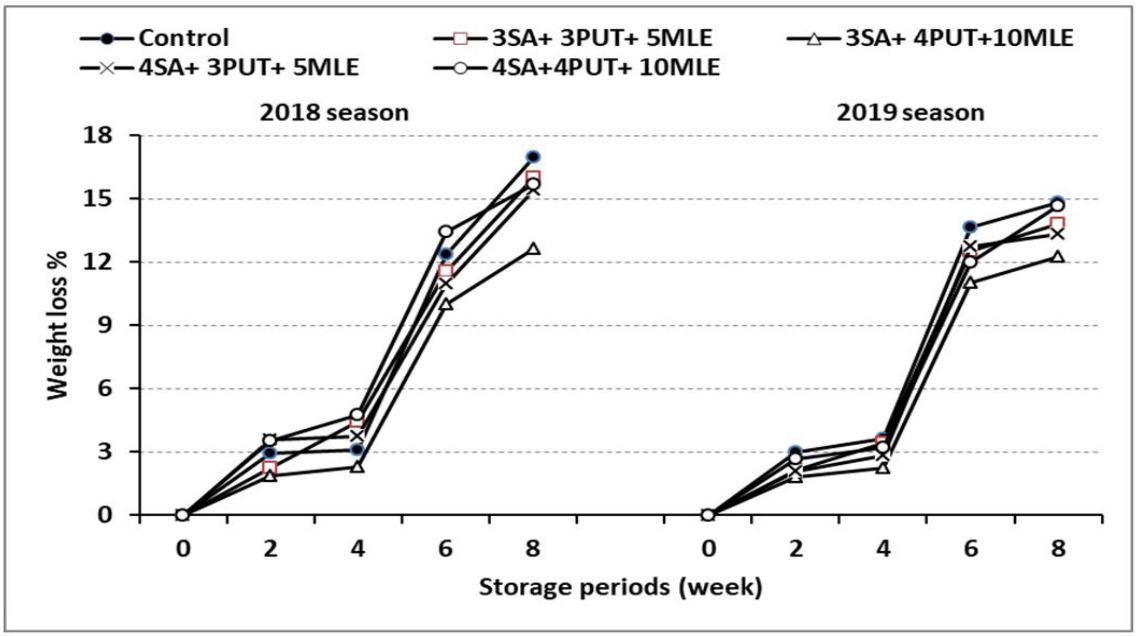

Figure 1. Effect of some pre-harvest treatments on weight loss % of plum fruit 'Golden Japan' during storage at 0°C and RH 85-90%

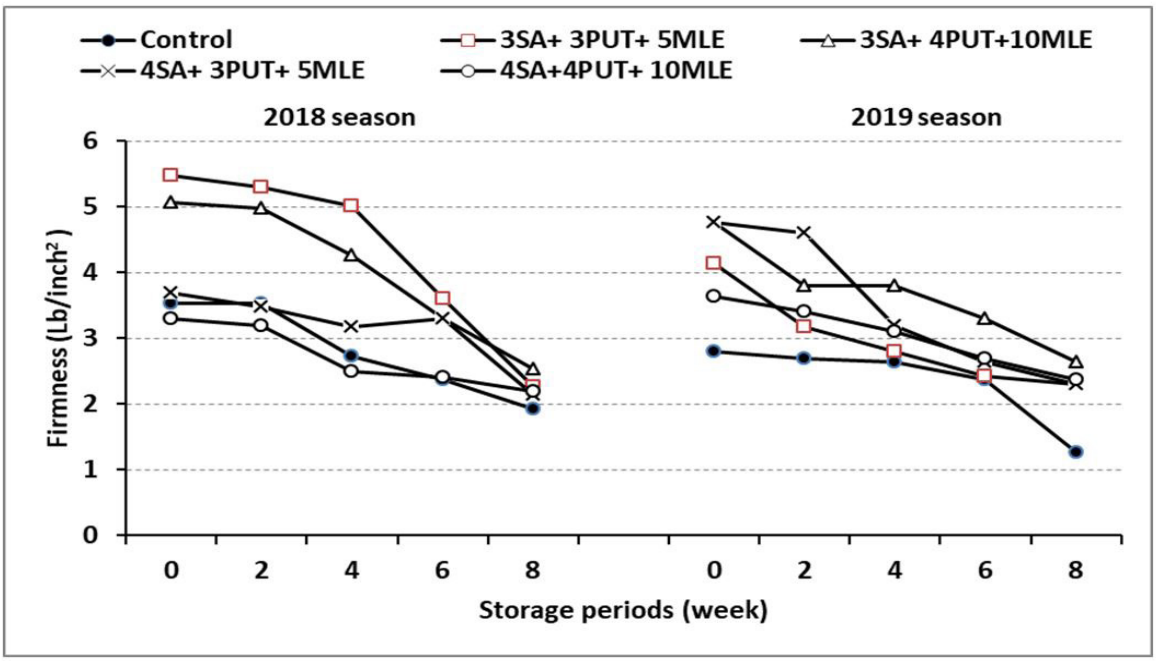

Figure 2. Effect of some pre-harvest treatments on fruit firmness of plum fruit 'Golden Japan' during storage at 0°C and RH 85-90%

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were significant differences among all treatments compared with control fruits in both seasons. At the end of storage, fruits that were treated with 3SA+ 4PUT+10MLE had significantly higher fruit firmness. On the contrary, control fruit treatment exhibited the lowest values of fruit firmness in the two seasons.

Fruit colour

Lightness (L*)

Data are shown in Table 1 indicate that, lightness (L*) significantly decreased with prolonging of storage period during the two seasons. At the end of the storage period, fruits treated by 4SA+ 3PUT+ 5MLE and 3SA+ 3PUT+ 5MLE recorded the highest significant difference of L* in the first and second seasons (48.85 and 46.98), respectively. Control fruits treatment exhibited the lowest values of L* (43.39 and 44.83) in the two seasons, respectively.

Hue angle (h° value)

Hue angle (h°) was decreased (increase density of yellow colour) with the advance in cold storage period (Table 2). Significant differences between all treatments were observed in the 2018 and 2019 seasons. At the end of the storage period, the lowest value of h° (high density of yellow colour) was recorded by 3SA+ 4PUT+10MLE in the two seasons. On the contrary, the highest values were recorded with control and 3SA+ 3PUT+ 5MLE treatments in first and second seasons, respectively.

Table 1. Effect of some pre-harvest treatments on L of plum fruit 'Golden Japan' during storage at 0°C and RH 85-90%

Treatments	Storage period per week					Storage period per week				
	2018					2019				
	0	2	4	6	8	0	2	4	6	8
Control	62.47C	61.36A	58.55A	58.55A	43.39D	59.75D	59.61C	58.11B	56.18A	44.83C
3SA+ 3PUT+ 5MLE	61.24C	55.62B	52.88B	48.72C	46.27C	62.09C	55.96D	55.22C	47.12D	46.98A
3SA+ 4PUT+10MLE	65.34B	56.85B	50.71C	49.02C	47.86B	63.51B	63.14A	53.67D	48.48C	46.86AB
4SA+ 3PUT+ 5MLE	67.78A	59.55A	58.77A	52.66B	48.85A	57.73E	60.86B	59.46A	49.20C	46.87AB
4SA+4PUT+ 10MLE	60.28C	59.66A	59.41A	49.76C	47.02BC	67.87A	61.15B	60.06A	52.42B	46.22B

Means within a column, following with the same letters are not significantly different according to Duncan multiple ranges test at the probability of 0.05 levels.

Table 2. Effect of some pre-harvest treatments on h° of plum fruit 'Golden Japan' during storage at 0 °C and RH 85-90%

Treatments	Storage period per week					Storage period per week				
	2018					2019				
	0	2	4	6	8	0	2	4	6	8
Control	104.5B	103.8A	104.0A	101.8A	100.1A	103.5AB	101.8B	101.7B	101.1A	95.93C
3SA+ 3PUT+ 5MLE	104.2B	103.7A	100.4BC	97.63B	97.19C	103.9A	103.6A	102.7A	99.62B	98.31A
3SA+ 4PUT+10MLE	102.2D	100.6C	99.34C	97.51B	94.46D	103.1BC	102.0B	100.1C	98.81C	95.35C
4SA+ 3PUT+ 5MLE	103.4C	101.7B	101.1B	100.9A	98.29B	103.8A	101.9B	101.6B	99.42BC	96.88B
4SA+4PUT+ 10MLE	105.6A	102.9A	101.1B	97.81B	97.20C	102.6C	99.31C	97.16D	96.66D	96.30BC

Means within a column, following with the same letters are not significantly different according to Duncan multiple ranges test at the probability of 0.05 levels.

Decay percentage

It is clear from the data in Figure 3 that all treatments significantly decreased decay percentage than the control fruits. However, all the used treatments did not give any decay fruits before 8 weeks of storage.

After 8 weeks of storage, data showed that fruits treated by 3SA+ 4PUT+10MLE recorded the lowest significant difference of decay percentage (4.5 and 3%) in the two seasons, respectively. On the contrary, control fruit treatment exhibited the highest values of decay percentage (50 and 45%) in the first and second seasons, respectively.

Total soluble solids (TSS)

Results in Table 3 display that Total Soluble Solids (TSS) content of fruits was gradually increased with the advance in cold storage up to 6 weeks and decreased after that. The statistical analysis indicated that there was a significant difference between the treatments during the storage periods in the two seasons of the study. After 8 weeks of storage, the highest values of TSS% were noticed by fruits treated by 4SA+ 3PUT+ 5MLE in the two seasons. On the contrary, 3SA+ 3PUT+ 5MLE fruits treatment exhibited the lowest percentage of TSS% in both seasons.

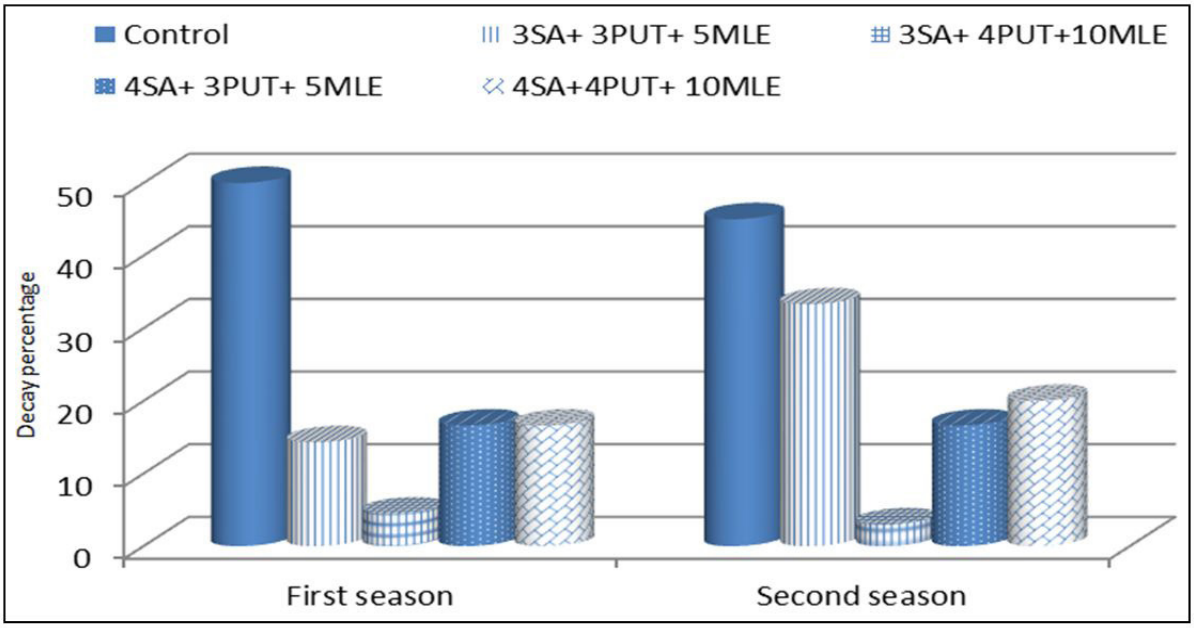

Figure 3. Effect of some pre-harvest treatments on decay percentage after 8 weeks of plum fruit 'Golden Japan' during storage at 0°C and RH 85-90%

Table 3. Effect of some pre-harvest treatments on TSS % of plum fruit 'Golden Japan' during storage at 0°C and RH 85-90%

Treatments	Storage period per week					Storage period per week				
	2018					2019				
	0	2	4	6	8	0	2	4	6	8
Control	10.20B	10.20B	12.20B	12.50B	13.27C	10.40B	10.33B	10.27C	12.50A	13.03B
3SA+ 3PUT+ 5MLE	13.07A	13.47A	13.54A	10.27C	10.27D	11.04A	12.07A	10.23C	10.30C	13.46AB
3SA+ 4PUT+10MLE	10.27B	10.27B	12.17B	13.30A	14.20A	10.27B	10.27B	11.13B	12.67A	13.51A
4SA+ 3PUT+ 5MLE	13.10A	10.27B	10.27D	13.50A	13.50B	10.23B	10.27B	12.73A	12.93A	13.17AB
4SA+4PUT+ 10MLE	10.23B	10.33B	11.23C	12.53B	13.50B	10.30B	10.30B	10.40C	11.27B	13.07B

Means within a column, following with the same letters are not significantly different according to Duncan multiple ranges test at the probability of 0.05 levels.

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Titratable acidity (TA)

TA of plum fruits decreased in all treatments with the progress of a cold storage period during both seasons of the study (Table 4). No significant difference between all treatments in most cases. Fruits treated by 3SA+ 4PUT+10MLE recorded the lowest TA% (0.061 & 0.063%) in the first and second seasons, respectively. Meanwhile, the untreated fruit recorded the highest TA% (0.066 & 0.071%) in the two seasons, respectively.

Total carotenoids content (TCC)

As clear in Figure 4, total carotenoids content was increased with the advance in cold storage periods. Significant effects by treatments were noticed in the 2018 and 2019 seasons. At the end of the storage period, the highest values were recorded with 3SA+ 4PUT+10MLE treatment in both seasons. While the lowest value of total carotenoids content was recorded by control in the two seasons.

Table 4. Effect of some pre-harvest treatments on titratable acidity (%) of plum fruit 'Golden Japan' during storage at 0°C and RH 85-90%

Treatments	Storage period per week					Storage period per week				
	2018					2019				
	0	2	4	6	8	0	2	4	6	8
Control	0.120A	0.070B	0.070A	0.067A	0.066A	0.101AB	0.094A	0.078A	0.074A	0.071A
3SA+ 3PUT+ 5MLE	0.101BC	0.094A	0.078A	0.074A	0.063A	0.112A	0.071B	0.067A	0.065A	0.064A
3SA+ 4PUT+10MLE	0.087C	0.083AB	0.069A	0.065A	0.061A	0.080C	0.078AB	0.074A	0.067A	0.063A
4SA+ 3PUT+ 5MLE	0.110AB	0.078AB	0.067A	0.065A	0.064A	0.094BC	0.087AB	0.069A	0.067A	0.067A
4SA+4PUT+ 10MLE	0.098BC	0.083AB	0.071A	0.071A	0.065A	0.101AB	0.076B	0.069A	0.067A	0.067A

Means within a column, following with the same letters are not significantly different according to Duncan multiple ranges test at the probability of 0.05 levels.

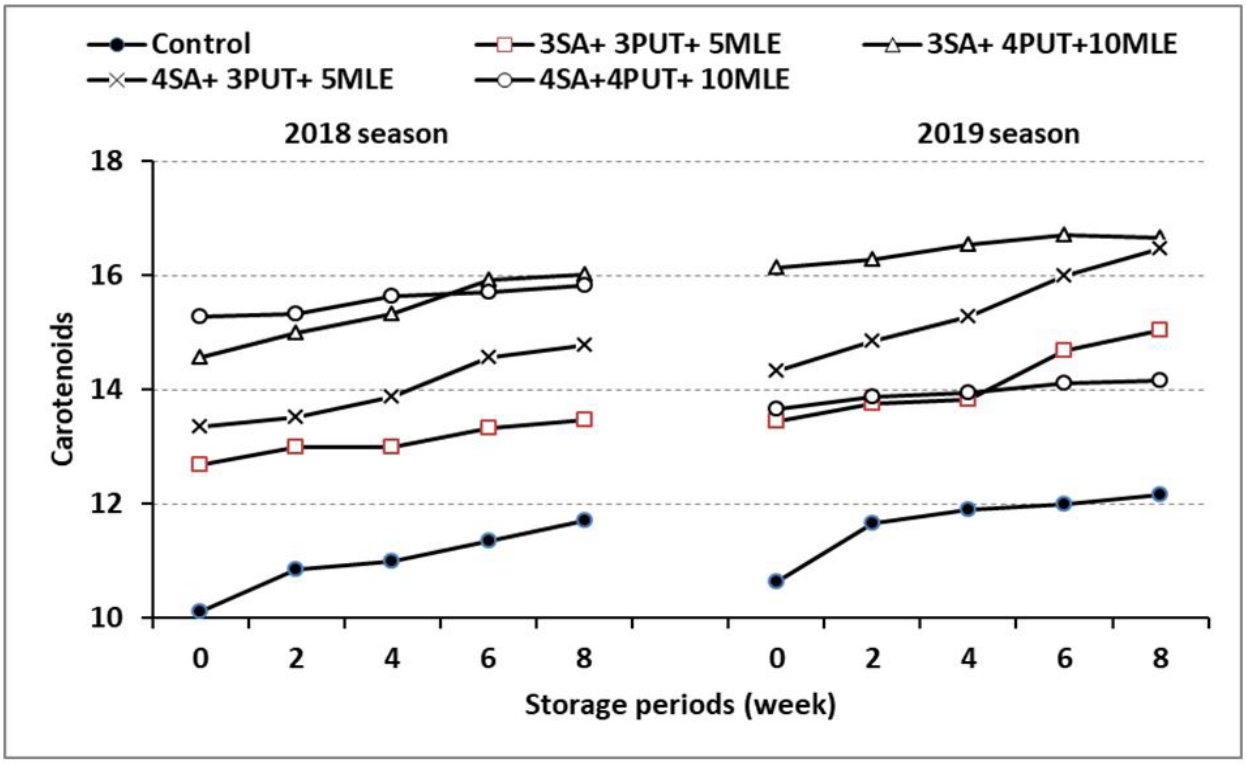

Figure 4. Effect of some pre-harvest treatments on total carotenoids content of plum fruit 'Golden Japan' during storage at 0°C and RH 85-90%

Total phenolics content (TPC)

As shown in Figure 5, total phenolics content increased significantly by the conducted treatments and the storage periods. After 8 weeks of storage, the highest value of total phenolic content (78.83 and 78.86) was recorded by 3SA+ 4PUT+10MLE in both seasons, respectively. On the other hand, 4SA+4PUT+ 10MLE treatment exhibited the least values (70.81 and 72.85) in the first and second seasons, respectively.

Total flavonoids content (TFC)

Data shown in Figure 6 indicate that total flavonoids content decreased gradually and significantly with extended storage periods during the two seasons. At the end of storage, the highest value was obtained by fruits treated with 3SA+ 4PUT+10MLE in the first season and 4SA+ 3PUT+ 5MLE in the second season without a significant difference between them.

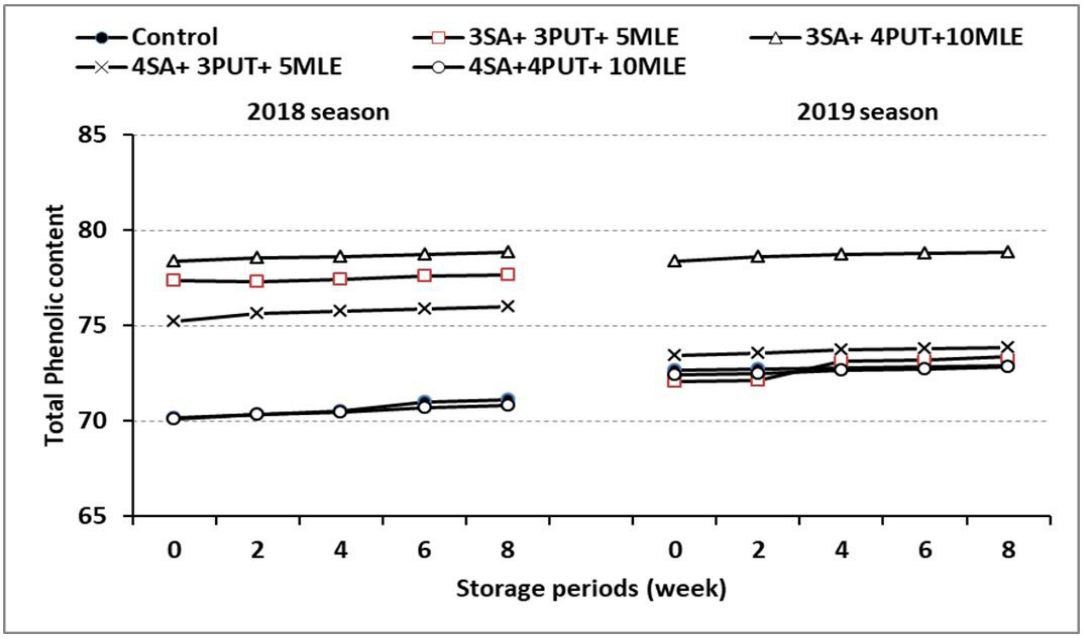

Figure 5. Effect of some pre-harvest treatments on total phenolic content of plum fruit 'Golden Japan' during storage at 0 °C and RH 85-90%pan' during storage at 0 °C and RH 85-90%

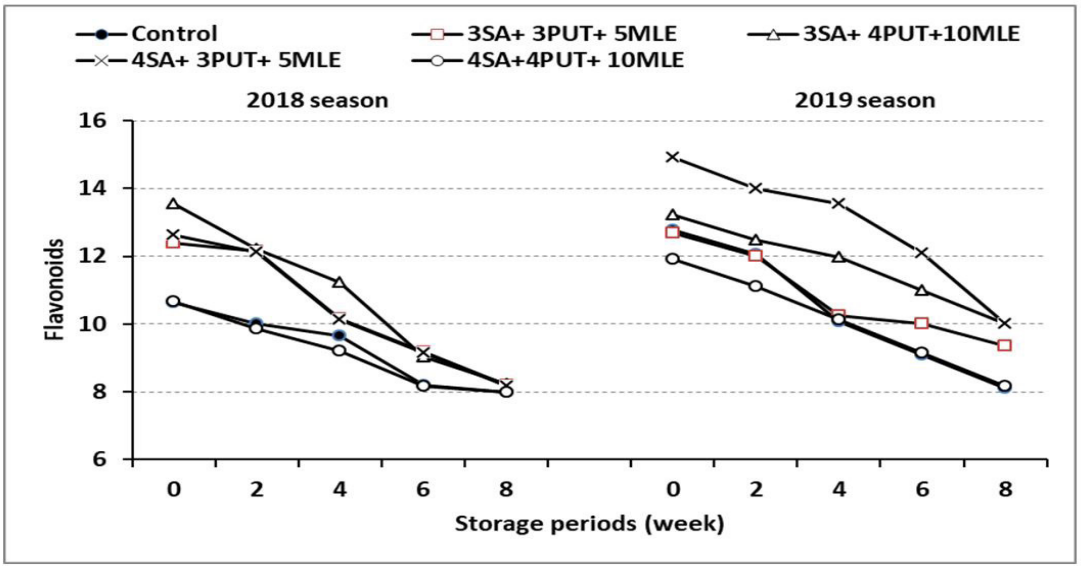

Figure 6. Effect of some pre-harvest treatments on total flavonoids of plum fruit 'Golden Japan' during storage at 0 °C and RH 85-90%

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Antioxidant activity (AA)

Results in Table 5 show that all studied treatments increased antioxidant activity more than the control fruits. However, antioxidant activity decreased with the advance in cold storage period. After 8 weeks of storage, the highest significant difference of antioxidant activity was recorded by 4SA+ 3PUT+ 5MLE in both seasons. On the other hand, control treatment exhibited the least significant antioxidant activity in the two seasons.

4. Discussion

In the present study, foliar application of SA, PUT and MLE on plum 'Golden Japan' trees resulted in a significantly slower rate of physiological fruit weight loss during storage at 0°C, and these results were consistent with those previously reported by Serrano et al., (2003), Ghasemnezhad et al. (2010), Davarynejad et al., (2015) who found that the exogenous application of putrescine caused significantly less fruit weight loss during storage. It was previously showed that the weight loss of apple fruit significantly decreases in salicylic acid treatment in comparison to control treatment during storage (Díaz-Mula et al., 2009).

The weight loss of fruit throughout the storage period could be due to the water exchange between the internal and external atmosphere, and the transpiration rate is accelerated by the cellular breakdown (Woods 1990). The obtained results detected that putrescine treatment decreased weight losses during storage. This effect might be due to a modification in a delay of the removal of epicuticular waxes which play an important role in water exchange through the skin. Zheng and Zhang (2004) reported that salicylic acid caused a reduction in the rate of respiration and weight loss of fruit by closing stoma. Moreover, Abbasi et al., (2019) reported a negative correlation between concentrations of salicylic acid, putrescine and weight loss, this may be due to its anti-senescence properties (Foidle et al., 2001); Nasira et al., 2016). The MLE may have maintained the membrane stability or integrity of the epicuticular wax of plum fruit, thereby reducing the rate of moisture loss from the fruit during cold storage.

Fruit softening is another important factor responsible for limiting the storage life of horticultural crops (Brummell and Harpster 2003). It is associated with deleterious changes in the metabolism of cell wall carbohydrates as well as the structural components of the cell wall (Labavitch 2003). These changes are triggered by the activities of hydrolytic enzymes (Payasi et al., 2009). In this study, the maintenance of higher flesh firmness of 'Golden Japan' plum in response to salicylic acid and putrescine and moringa leaf extract application may be attributed to the reduced activities of the fruit-softening enzymes. These results are in agreement with Aghdam et al., (2009) in kiwifruit; Valero et al., (2011) in sweet cherry; Abbasi et al., (2019) in peach who found that treatment with exogenous polyamines has been reported to maintain fruit firmness during storage. Also, Serrano et al., (2003) and Davarynejad et al., (2015) reported that the treated plum fruits with salicylic acid and putrescine had the highest level of fruit firmness during storage.

Most fruits lose firmness and soften with an accelera-

Table 5. Effect of some pre-harvest treatments on Anti-oxidant of plum fruit 'Golden Japan' during storage at 0°C and RH 85-90%

Treatments	Storage period per week					Storage period per week				
	2018					2019				
	0	2	4	6	8	0	2	4	6	8
Control	57.58D	57.33C	53.78D	50.45E	50.11E	60.17E	60.00E	59.26E	55.17E	52.08E
3SA+ 3PUT+ 5MLE	57.63C	57.19D	55.37C	54.82C	52.25C	67.19C	66.34C	64.67C	63.88A	61.00B
3SA+ 4PUT+10MLE	69.17A	65.18B	64.62A	60.09B	60.00B	68.11B	67.22B	65.55B	63.71B	60.16C
4SA+ 3PUT+ 5MLE	67.78B	65.73A	62.61B	62.08A	61.94A	68.54A	68.01A	66.35A	63.46C	62.15A
4SA+4PUT+ 10MLE	56.18E	55.09E	53.43E	52.44D	50.27D	66.09D	65.87D	63.81D	61.94D	59.00D

Means within a column, following with the same letters are not significantly different according to Duncan multiple ranges test at the probability of 0.05 levels.

tion of the ripening process, exhibiting a loss of quality during the storage period. The polyamines influence on firmness augmentation can be attributed to their capacity cross-link to pectic substances in the cell wall, resulting in rigidification that is detectable immediately after treatment (Abbott et al., 1989) and also as inhibition of the action of wall-degrading enzymes, such as pectinesterase, pectin methylesterase and polygalacturonase, which reduces fruit softening during storage (Valero et al., 2002). Kazemi et al., (2011) reported that the effect of salicylic acid on the reduction of fruit softening can be attributed to ACO (1-aminocyclopropane-1-carboxylic acid oxidase) inhibitory activity, and therefore on ACC (1-aminocyclopropane- 1-carboxylic acid) conversion to ethylene. Following this hypothesis, the exogenously applied putrescine and salicylic acid went to cell walls to maintain high levels of fruit firmness and these high levels of firmness lead to increased shelf life.

Fruit colour plays an important role in consumer attraction. Plum fruit colour is associated with the accumulation of carotenoids and anthocyanins. Both groups of pigments are more abundant in the peel but carotenoids are mainly responsible for the surface colour of 'Golden Japan' plums. The ripening phenomenon in fresh produce is meticulously associated with the degradation of photosynthetic pigments coupled with the concomitant increases in the levels of phenolic pigments. Similarly, storage regime substantially influences the exterior colour (Abbasi et al., 2019).
The slower changes in the lightness (L*) and hue angle (h°) on the surface of plum fruit after SA, PUT and MLE application may be ascribed to the delay in chlorophyll senescence with the reduced rate of fruit ripening.

These results are in harmony with those obtained by Martínez-Esplá et al., (2017) who reported that the application of salicylic acid has been a successful production practice to ensure optimum colour development on the fruit surface after long-term cold storage was evaluated in two plum cultivars "Black Splendor" and "Royal Rosa". Similar data were also reported by treatment with exogenous polyamines for apricot (Martínez-Romero et al., 2001) and mango (Malik and Singh 2005). Additionally, applying preharvest with moringa leaf extract increases the pigment contents in fruits due to its mineral richness, which enhance the activity of enzymes, hence the appearance of coloured pigments Thanaa and others (2017), and may this lead to high levels of fruit colour maintenance during ripening, either on trees or during storage.

Along with storage, TSS increased in plums from control and treated trees. The increase in total soluble solids content during storage was probably due to the concentrated juice content as a result of dehydration and hydrolysis of polysaccharides.

The obtained results indicated that all treatments showed significant increases in the content of total soluble solids during the storage period. This effect of salicylic acid, putrescine and moringa leaf extract can be attributed to its roles in lowering the respiration rate and delaying the conversion of starch into simple sugars and other impacts, such as decreasing the weight loss and ethylene biosynthesis, hence delaying the ripening process Davarynejad and others (2015).

This result is in accordance with that of Baljit and Jawandha (2014) who summarized that putrescine 3 mmol L−1 sprayed 10 days before harvesting of peach fruits registered high TSS% at the end of storage. Moreover, Aly et al., (2019) found that pre-harvest foliar application with putrescine and salicylic acid at (200, 400, 600 ppm) significantly increased total soluble solids content of "Anna" apple during cold storage. Additionally, Thanaa et al., (2017) reported that foliar application of moringa leaf extract at full bloom stage, fruit setting stage and two weeks after fruit setting stage significantly increased the soluble solids content of "Hollywood" plum.

The titratable acidity is an important factor in maintaining the quality of plum fruits, which is directly related to the organic acid content present in the fruit. Zokaee-Khosroshahi et al., (2007) and Ishaq et al., (2009) reported that the decrease of titratable acidity content could be due to consumption of organic acids in fruits during respiration. In the present study, it seems that salicylic acid, putrescine and moringa leaf extract treatments did have a significant effect on respiration process which could result in reduction or delay of respiration and maintain titratable acidity content. This result was in agreement with the report by Davarynejad et al., (2015)as well as Thanaa et al., (2017).

Plums have been reported as a rich source of antiox-

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idant compounds with beneficial health effects such as carotenoids and phenolics as compared with other fruits of the Mediterranean, although important differences in their concentration are found depending on the cultivar (Igwe and Charlton 2016); Sahamishirazi et al., 2017). It is interesting to note that SA, PUT and MLE preharvest treatment led to increased levels of total carotenoids (TCC) and total phenolic content (TPC) in 'Golden Japan' plum cultivar compared to control, as well as these levels remained still at significantly higher concentration after 8 weeks of storage. No previous reports published are available regarding the effect of these treatments either applied as a post or preharvest treatments on total carotenoid content, with the exception of one paper previously published. It showed that SA preharvest treatment of "Black Splendor" and "Royal Rosa" plum led to increasing total carotenoid content and maintenance during 50 days of storage compared to control fruits (Martínez-Esplá et al., 2017).

Concerning their effect on phenolic content, our results are in harmony with those obtained in plums (Martínez-Esplá et al., 2017), in sweet cherry (Giménez et al., 2016) and apricot (Wang et al., 2015). SA postharvest treatment increased levels of total phenolics and these levels were maintained during cold storage. These enhancements may be attributed to an increase of phenylalanine ammonia lyase activity, which is the main enzyme involved in the biosynthetic phenolic pathway (Martínez-Esplá et al., 2017). On the other hand, Davarynejad et al., (2015) found that applying 4 mmol/L putrescine and 4 mmol/L salicylic acid treatments on 'Santa Rosa' plum significantly decreased the content of total phenolics during storage at 4°C.

In this study, total flavonoids content decreased gradually and significantly with extended storage periods. Similar results were found on peach fruits (Zhang et al., 2014) and on apples (Chaparzadeh and Yavari 2013). They reported that total flavonoids content decreased significantly towards the end of cold storage.

The decreases in flavonoid content were delayed by all treatments, especially application of 3mmol/LSA plus 4 mmol/L PUT plus 10% MLE, that produced the highest significant values than those found in the control which recorded the lowest flavonoid content. This could be mainly due to activating the metabolic pathway for the synthesis of flavonoid compounds with SA, PUT and MLE preharvest treatment. These results are following the findings by Bal (2016) on nectarine fruits who reported that exogenous application of salicylic acid treatment at 0.5 mM significantly increased total flavonoid content by the 30th day of storage.

Reduction of antioxidant activity of 'Golden Japan' plum with the advance in cold storage period could be attributed to the reduction in TPC, TFC and other biochemical compounds.

This result agreed with Tsantili and others (2010) who reported that higher phenolic compound levels could change antioxidant activity and also showed a linear correlation between phenolic compounds and antioxidant activity. At the end of the storage period, the treatments of salicylic acid, putrescine and moring leaf extract maintained antioxidant activity of the fruit significantly during storage. The highest significant different of antioxidant activity were recorded by 3mmol/L SA plus 4 mmol/L PUT plus 10% MLE), the lowest antioxidant activity was recorded in control fruits. This was probably due to it is impacts in maintaining of TCC, TPC and TFC during storage. This is in agreement with Barman and Asrey, (2014); Davarynejad et al., (2015) and Bal (2016).

5. Conclusion

In conclusion, salicylic acid, putrescine and moringa leaf extract play a very effective role in controlling the fruit weight loss, decay, softening and other compositional changes such as titratable acidity, total soluble solids, total carotenoids, total phenolics, total flavonoids and antioxidant activity of plum fruits during cold storage. Especially SA at 3mmol/ L, PUT at 4 3mmol/ L and MLE at 10% treatment delayed the ripening process more effectively and with minimum quality loss as compared to the control samples which had greater compositional changes with maximum quality loss. Thus, can be used commercially to extend the storage life of postharvest plum fruit and preserve fruits with acceptable quality attributes.

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Conflict of Interests

The authors hereby declare that there is no conflict of interests.

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Research Paper

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Estimate of correlation between the meteorological drought in Ethiopia and the hydrological drought in Egypt

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Drought is one of the most complex natural phenomena and one of the main natural causes affecting agriculture, the economy, and the environment worldwide, and its global impact has become significantly evident in the level of life in recent decades. Drought happens in different regions, so assessing the intensity of the drought period is one of the most important tools for sustainable agriculture, as droughts have become observable in many parts of the world, especially in the East and North Africa region. The most important types of drought are meteorological and hydrological drought, Drought indices were used to survey drought and demonstrate its performance. Egypt suffers from water scarcity, especially in recent years. Therefore, the importance of studying Ethiopia as a research area comes due to the presence of the Blue Nile, which contributes about 85% of the Nile River's revenue. Meteorological drought was evaluated by calculating the Standard Precipitation Index (SPI), and hydrological drought was calculated by the Streamflow Drought Index (SDI) during the period of study from (1950 to 2017) based on the availability of the recorded data for meteorological stations in Ethiopia, and the streamflow for several stations. Then these data were evaluated using various methods, including homogeneity between the data for each station by considering the different time scales of periods 1, 3, 6, 9, and 12 months. As a result, there are three seasons of rain in Ethiopia. Kiremt is the main rainy season from June to September, Bega is the dry season from October to January, Belg is the lowest rainy season from February to May. Ethiopia, characterized by four precipitation regimes, was found to correlate with the meteorological index (SPI) for five stations in Ethiopia and the hydrological index (SDI) for Dongola.

1. Introduction

Drought is a major natural hazard phenomenon and its consequences can be destructive (Tigkas, 2008). Drought affects people and most sectors of society in comparison with other natural hazards (Wilhite, 2012), and it is the main natural cause for damage in agriculture, the economy, and the environment. A deficiency in precipitation is the main cause of drought (Vicente-Serrano et al., 2010). Drought is a worldwide phenomenon that is caused by the absence of precipitation. It causes damage to human lives, agriculture, and natural ecosystems (Zarch et al., 2011). Drought is classified into four types: meteorological, agricultural, hydrological, and socioeconomic. The two categories of drought concerning this paper are identi-

fied as 1) meteorological drought, which is defined as a divergence from ordinary precipitation over some timeframe, and reflects one of the essential causes of drought 2) Hydrological drought, which is defined as the insufficiencies on the surface and subsurface water supplies, and reflects impacts of drought. Meteorological drought usually appears first because of a decline in precipitation. Hydrological drought includes the shortage of water supply in the streamflow, reservoir storages, lakes, etc., and it is affected by meteorological drought management approaches (Boudad et al., 2018).

Egypt is an arid country that suffers from water scarcity especially in more recent years. Egypt depends on the Nile river as a lifeline that provides 95% of its water resources to cope with its growing population and water demands (Link, Piontek, Scheffran, & Schilling, 2012). Ethiopia has a diverse climate due to its equatorial position and the climate ranges from a semi-arid desert type in the lowlands, to humid and warm type in the southwest; the complex geographical and topographical characteristics in Ethiopia have a substantial impact on different precipitation regimes in the country (Kidanewold et al., 2014), so it is important to assess the variability of seasonal rainfall in selected areas of the region (Gebremichael et al., 2014).

One of the most common ways to evaluate drought is to calculate drought indices (Tigkas, 2008). Many indices aim to assess the severity of droughts. Some of the most popular indices that use only precipitation data are the Standardized Precipitation Index (SPI) and the Streamflow Drought Index (SDI)(Tsakiris et al., 2013). The objectives of this research are to assess the meteorological drought as well as to estimate the Standardized Precipitation Index (SPI) of Ethiopia and the Streamflow Drought Index (SDI) from the Nile River at the High Aswan Dam (HAD) downstream to Egypt and to find significant correlations between SPI and SDI.

2. Literature review

Mishra and Singh (2010) presented the essential concepts and characterization of drought, drought indices, and the relationship between droughts and climate indicators. Tsakiris et al. (2007) found that the most widely used drought indices in other countries are the Standardized Precipitation Index (SPI) and the Palmer Drought Severity Index (PDSI. Seleshi and Zanke (2004) analysed the recent changes in the annual rainfall totals for June to September, March to May, and other rainy days in 11 of Ethiopia's major stations located in five major climatic zones during the period 1965-2002. Vicente-Serrano and López-Moreno (2005) showed the main advantage of the SPI index is that it can determine and monitor drought at different time scales. From this research, for example, SPI was calculated at time scales from 1 to 24 months as an indicator of runoff in Spain. From previous literature, SPI is the most proper index for assessing the meteorological drought in humid regions.

3. Data and methods

The study area is the whole of Ethiopia, situated between 3° to 15° N latitude and 33° to 48° E longitude, with a total area of 1.13 million km2 as shown in Figure 1. The region has a highly irregular topography, characterised by the central and northern highlands, and the lowlands of the rift valley plain (Tadege, 2001). The elevation ranges from -125 m to 4620 m (Cheung et al., 2008; Dawit, 2010). The temperature increases towards the southeast region and decreases towards the central region; the climate varies mostly because of the altitude. The southwest of the country is characterized by maximum precipitation levels, while the southeast of the country has the minimum.

Data sets used in this study were monthly precipitation, temperature (minimum and maximum), and streamflow data collected at fifteen stations covering different parts of Ethiopia and Dongola station. These values were used to calculate the SPI and SDI index. The period of study (1950–2017) has been chosen based on the availability of recorded data for all stations.

Dongola station is viewed as a standout among other discharge estimating stations on the Nile River as its discharges are utilized to quantify the water arriving at Nasser Lake and to gauge water losses (Mohamed, 2016). Drought can be measured and analysed by different indices. In this study, SPI and SDI indices were used as described below.

SPI was developed to improve the Palmer index for representing wet and dry conditions (Guttman, 1999). SPI for any site is based on the long-term precipita-

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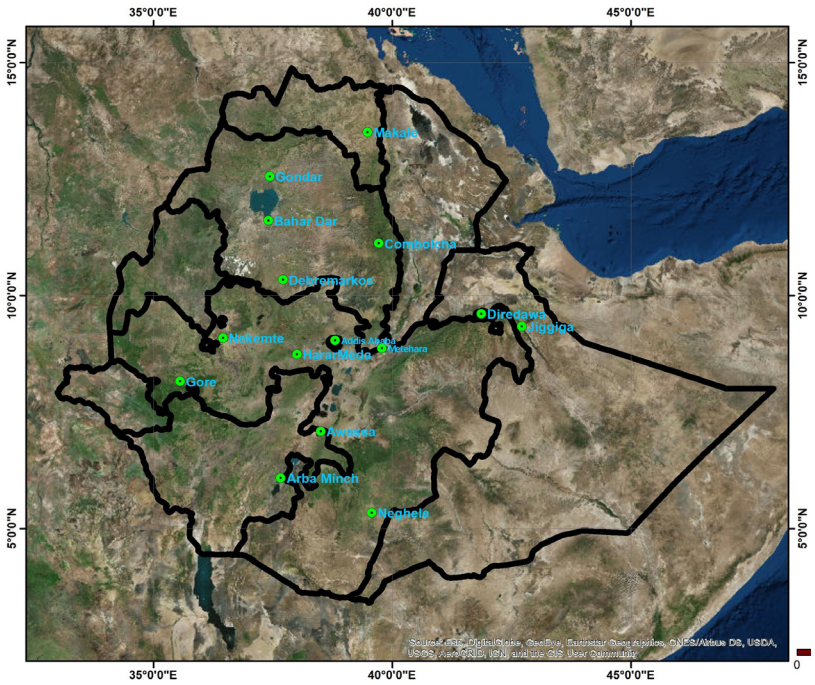

Figure 1. Location of climatic stations used in this study in Ethiopia.

tion record (longer than 45 years) and is fitted to a probability distribution (Boudad, Sahbi, & Mansouri, 2018). from 1950 to 2017, SPI was based on high cumulative rainfall (Rik) for the basis period (k) relating to (i) hydrological year and is obtained by the following equation:

$$SPI_{ik} = \frac{R_{ik} - \overline{R_k}}{S_k} \qquad i = 1,2,\ldots \qquad k = 1,2,3,4,5,6$$

$\overline{Rk}$ and Sk is the mean height of cumulative rainfall and the standard deviation cumulative rainfall, respectively, for the period k (Azareh et al., 2014). SPI values appear in Table 1.

SDI is based on monthly observed streamflow volumes at different time scales (Boudad et al., 2018) obtained from monthly precipitation and it has been used for monitoring drought and helping decision-makers assess risk (Guttman, 1999).

In this study, SDI was similar to SPI. SDI is the high cumulative flow (V ik) for the basis period (k) relating to (i) hydrological year and is obtained by the following equation:

$$SDI_{ik} = \frac{V_{ik} - \bar{V}_k}{S_k} \qquad i = 1,2,\ldots \qquad k = 1,2,3,4,5,6$$

$\overline{Vk}$ and Sk are the mean total volume flow and the standard deviation of cumulative flow volume, respectively, based on period k (Azareh et al., 2014). SDI values appear in Table 1.

To facilitate the process, a Drought Indices Calculator was used with DrinC software developed at the National Technical University of Athens Management (Tsakiris et al., 2007). The version of the software can be found at www.ewra.net/drinc.

To study the relationship between meteorological and hydrological drought, the correlation coefficients of Pearson for all series were first calculated. In the second step, and to imagine this relationship, the Pearson coefficient was calculated between each period of SPI and SDI at different time scales (for 1, 3, 6,9, and 12 months).

The correlation coefficient is a statistic used to measure the degree or strength of this type of relationship and to take on a range of values from -1 to 0 to +1 (Taylor, 1990). If r is close to 0, it means there is no relationship between variables. A positive correlation coefficient indicates a direct relationship between the variables. A negative correlation indicates an inverse relationship between the two variables (Taylor, 1990).

Table 1. Classification of drought according to the SPI and SDI values (Azareh et al., 2014).

Index values of drought SPI or SDI	Category
2.00 or more	Extremely wet
1.50 to 1.99	Severely wet
1.00 to 1.49	Moderately wet
0 to 0.99	Normal conditions- wet
0 to -0.99	Normal conditions - dry
-1.00 to -1.49	Moderate Drought
-1.50 to -1.99	Severe Drought
-2 or less	Extreme Drought

4. Results and discussions

Ethiopia's diverse topography contributes to the high spatial and temporal variability of precipitation in the country. Generally, the southwest of the country is characterized by maximum precipitation levels while the southeast of the country typically has the minimum precipitation levels. Ethiopia is distinguished by four seasonal precipitation systems according to the precipitation regime shown in Figure 2 that represents stations located in these regimes.

Evaluation of the Standardized Precipitation Index (SPI)

After the calculation of SPI values, Figure 3 shows the SPI distribution over Ethiopia. Results showed Kirmet as the main rain season in which extreme, heavy precipitation falls on most of the country, except for the south and south-eastern parts. Belg is the main rain season for the south and south-eastern. This agreed with the findings of Dawit (2010) and with Shang et al. (2011).

This study represented SPI at multiple time scales of 1, 3, 6, 9, and 12 months to identify the drought behaviour. The time scale refers to any number of months of accumulated SPI values. Additionally, short time scales of 3-months are important for agricultural applications, while long time scales are important in water-supply management (Guttman, 1998). When time series are small, 3 or 6 months, the SPI values

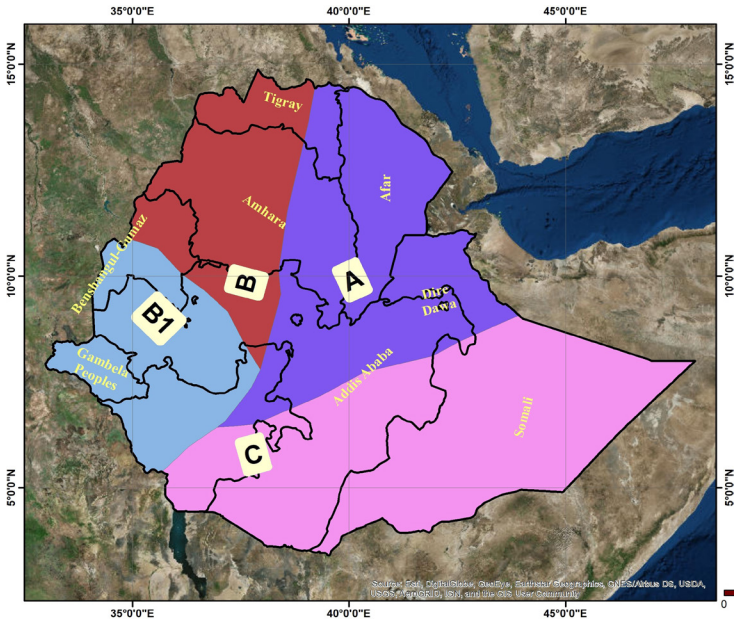

Figure 2. Precipitation Regimes of Ethiopia (A, B, B1, C) and the location of the stations (Dawit et al.,2011)

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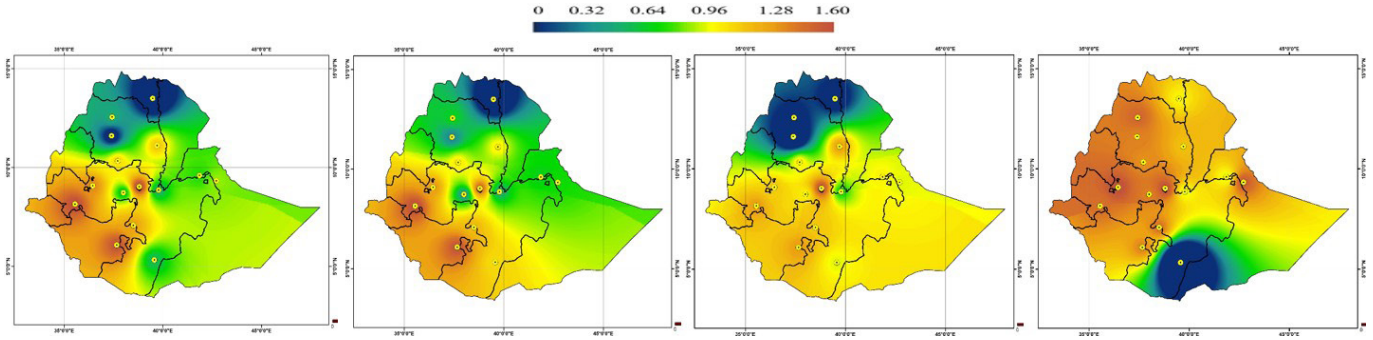

Figure 3. The distribution of annual SPI values for Ethiopia

are small, whereas for longer periods, for example, 12 months, the SPI has a slow response to changes in precipitation. After analysis SPI and SDI and calculation of annual change of the indices that describe the long term time series of precipitation observations, and according to Awulachew et al. (2009) represent climate stations, located in the or near the Blue Nile Basin (including Addis Ababa, Bahar Dar, Debre Markos, Gondar and Gore), therefore correlation coefficients had estimated for that five selected stations with Dongola at different time scale .

Estimation of the correlation coefficient

A comparison of SPI values for the selected stations located in the Blue Nile Basin and SDI for Dongola at 1, 3, 6, 9, 12 months was carried out. Results showed significant correlations and non-significant correlations. The frequency of a statistically significant correlation was moderate for monthly scales, where it reached its maximum at a 3-month scale, followed by a 6-month scale, and less frequently at a 9-month scale and no significance at a 12-month scale. Table 2 through Table 6 represent the correlations between SPI for the five stations and SDI for Dongola at 3-month intervals. The coloured values represent significant values at 0.01 and 0.05 level. Table 6 is illustrated in Figure 4 and shows the behaviour of the correlation between SPI for Gore and SDI for Dongola (as an example). As a result, Dongola is affected more by the drought in each of Bahar Dar, Debremarkos, and Gore.

Table 2. Correlation between SPI for Addis Ababa and SDI for Dongola

SDI3 Dongola	Oct-Dec	Nov-Jan	Dec-Feb	Jan-Mar	Feb-Apr	Mar-May	Apr-Jun	May-Jul	Jun-Aug	Jul-Sep	Aug-Oct	Sep-Nov
Oct-Dec	0.11	-0.24	-0.20	-0.14	-0.20	-0.21	-0.12	0.04	0.07	0.21	0.16	0.28
Nov-Jan	0.12	-0.21	-0.16	-0.08	-0.17	-0.20	-0.10	0.08	0.09	0.09	0.08	0.15
Dec-Feb	0.02	-0.22	-0.10	0.03	-0.08	-0.18	-0.12	0.04	0.10	0.02	0.06	0.09
Jan-Mar	0.01	-0.14	-0.12	0.04	-0.10	-0.06	-0.05	0.10	0.04	-0.06	0.02	0.01
Feb-Apr	-0.03	-0.14	-0.18	0.00	-0.10	0.02	0.04	0.16	-0.05	-0.05	0.01	0.10
Mar-May	-0.06	-0.15	-0.25	-0.01	-0.09	0.05	0.04	0.18	-0.10	0.05	0.05	0.26
Apr-Jun	0.00	-0.04	-0.28	-0.10	-0.20	0.01	-0.06	0.05	-0.11	0.17	0.21	0.33
May-Jul	0.02	0.01	-0.30	-0.14	-0.16	-0.01	0.11	0.23	0.27	0.33	0.28	0.23
Jun-Aug	0.01	0.02	-0.20	-0.09	-0.14	-0.10	-0.05	0.10	0.14	0.20	0.13	0.20
Jul-Sep	-0.02	-0.07	-0.14	-0.05	-0.10	-0.12	-0.07	0.10	0.14	0.23	0.10	0.23
Aug-Oct	0.04	-0.06	-0.11	-0.01	-0.08	-0.11	-0.14	0.02	0.03	0.12	0.07	0.22
Sep-Nov	0.10	-0.10	-0.09	0.00	-0.09	-0.11	-0.13	0.03	0.03	0.11	0.11	0.24
	SIP3 Addis Ababa											

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Table 3. Correlation between SPI for Bahar Dar and SDI for Dongola

SDI3 Dongola	Oct-Dec	Nov-Jan	Dec-Feb	Jan-Mar	Feb-Apr	Mar-May	Apr-Jun	May-Jul	Jun-Aug	Jul-Sep	Aug-Oct	Sep-Nov
Oct-Dec	0.49	0.20	0.24	0.24	0.23	0.19	0.12	0.17	0.18	0.26	0.34	0.46
Nov-Jan	0.61	0.26	0.17	0.09	0.23	0.34	0.29	0.34	0.36	0.43	0.50	0.56
Dec-Feb	0.43	0.22	0.09	0.05	0.26	0.30	0.31	0.34	0.39	0.46	0.50	0.54
Jan-Mar	0.30	0.11	-0.06	0.03	0.19	0.30	0.33	0.25	0.30	0.31	0.31	0.25
Feb-Apr	0.26	0.03	-0.11	0.05	0.18	0.34	0.36	0.21	0.21	0.19	0.21	0.18
Mar-May	0.13	-0.01	-0.12	0.05	0.12	0.36	0.30	0.13	0.05	0.02	0.07	0.10
Apr-Jun	0.00	-0.11	-0.12	0.25	0.13	0.30	-0.09	-0.24	-0.36	-0.33	-0.23	-0.19
May-Jul	-0.01	-0.06	-0.03	0.17	0.04	0.19	-0.24	-0.37	-0.52	-0.47	-0.33	-0.22
Jun-Aug	0.02	0.08	0.15	0.06	0.01	0.10	-0.14	-0.14	-0.27	-0.27	-0.26	-0.14
Jul-Sep	0.06	0.20	0.26	0.03	0.02	0.05	-0.12	-0.06	-0.11	-0.10	-0.08	0.01
Aug-Oct	0.13	0.22	0.31	0.04	-0.02	0.14	-0.03	0.04	-0.04	-0.04	-0.04	0.05
Sep-Nov	0.25	0.27	0.34	0.09	-0.03	0.28	0.05	0.10	0.00	0.02	0.09	0.21
	SIP3 Bahar Dar											

Table 4. Correlation between SPI for Debre Markos and SDI for Dongola

SDI3 Dongola	Oct-Dec	Nov-Jan	Dec-Feb	Jan-Mar	Feb-Apr	Mar-May	Apr-Jun	May-Jul	Jun-Aug	Jul-Sep	Aug-Oct	Sep-Nov
Oct-Dec	0.28	-0.07	0.08	0.06	0.07	0.04	0.12	0.16	0.06	0.11	0.28	0.46
Nov-Jan	0.50	0.13	0.18	0.20	0.26	0.24	0.37	0.42	0.29	0.31	0.41	0.59
Dec-Feb	0.42	0.25	0.21	0.23	0.34	0.36	0.47	0.55	0.47	0.47	0.41	0.53
Jan-Mar	0.33	0.25	0.13	0.09	0.22	0.36	0.39	0.47	0.36	0.34	0.17	0.29
Feb-Apr	0.35	0.16	0.04	0.03	0.13	0.37	0.37	0.38	0.25	0.27	0.17	0.32
Mar-May	0.24	0.05	-0.08	-0.09	-0.03	0.27	0.19	0.10	-0.05	0.01	0.07	0.30
Apr-Jun	0.08	-0.17	-0.32	-0.35	-0.32	-0.07	-0.23	-0.32	-0.50	-0.44	-0.36	-0.13
May-Jul	-0.16	-0.30	-0.39	-0.32	-0.39	-0.24	-0.36	-0.47	-0.60	-0.60	-0.43	-0.32
Jun-Aug	-0.12	-0.36	-0.24	-0.28	-0.28	-0.18	-0.25	-0.33	-0.38	-0.34	-0.24	-0.18
Jul-Sep	-0.13	-0.33	-0.15	-0.17	-0.21	-0.14	-0.20	-0.24	-0.24	-0.18	-0.05	-0.03
Aug-Oct	-0.02	-0.27	-0.10	-0.11	-0.15	-0.05	-0.13	-0.16	-0.20	-0.13	-0.06	0.03
Sep-Nov	0.08	-0.14	-0.04	0.01	-0.10	0.04	-0.06	-0.08	-0.16	-0.10	0.01	0.16
	SIP3 Debremarcos											

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Table 5. Correlation between SPI for Gondar and SDI for Dongola

SDI3 Dongola	Oct-Dec	Nov-Jan	Dec-Feb	Jan-Mar	Feb-Apr	Mar-May	Apr-Jun	May-Jul	Jun-Aug	Jul-Sep	Aug-Oct	Sep-Nov
Oct-Dec	0.33	0.22	0.45	0.27	0.11	0.20	0.18	0.18	0.23	0.26	0.33	0.37
Nov-Jan	0.58	0.41	0.47	0.29	0.26	0.41	0.38	0.41	0.43	0.46	0.53	0.53
Dec-Feb	0.47	0.41	0.36	0.34	0.35	0.53	0.41	0.40	0.38	0.41	0.45	0.52
Jan-Mar	0.37	0.25	0.20	0.25	0.29	0.47	0.23	0.22	0.19	0.25	0.33	0.39
Feb-Apr	0.33	0.18	0.18	0.20	0.20	0.29	0.02	0.01	0.00	0.07	0.17	0.25
Mar-May	0.14	0.07	0.08	0.14	0.13	0.11	-0.11	-0.18	-0.19	-0.18	-0.10	0.02
Apr-Jun	-0.06	-0.11	-0.12	0.19	0.08	-0.08	-0.23	-0.37	-0.39	-0.40	-0.31	-0.21
May-Jul	-0.09	-0.17	-0.10	0.12	0.05	-0.07	-0.02	-0.17	-0.21	-0.25	-0.15	-0.09
Jun-Aug	0.04	-0.03	0.11	0.06	0.01	-0.04	0.12	0.08	0.14	0.08	0.05	-0.06
Jul-Sep	0.06	0.02	0.19	0.05	0.00	0.00	0.18	0.20	0.28	0.23	0.17	0.05
Aug-Oct	0.14	0.08	0.21	0.05	-0.02	0.05	0.18	0.19	0.26	0.22	0.16	0.02
Sep-Nov	0.23	0.15	0.21	0.06	-0.02	0.16	0.20	0.19	0.20	0.17	0.18	0.15
	SIP3 Gondar											

Table 6. Correlation between SPI for Gore and SDI for Dongola

SDI3 Dongola	Oct-Dec	Nov-Jan	Dec-Feb	Jan-Mar	Feb-Apr	Mar-May	Apr-Jun	May-Jul	Jun-Aug	Jul-Sep	Aug-Oct	Sep-Nov
Oct-Dec	0.27	0.01	0.06	-0.01	0.14	0.41	0.39	0.25	0.07	0.07	0.11	0.14
Nov-Jan	0.48	0.30	0.30	0.25	0.36	0.63	0.58	0.53	0.38	0.38	0.43	0.43
Dec-Feb	0.46	0.41	0.42	0.35	0.42	0.65	0.57	0.55	0.48	0.49	0.47	0.43
Jan-Mar	0.50	0.33	0.30	0.23	0.31	0.52	0.49	0.47	0.45	0.44	0.37	0.28
Feb-Apr	0.46	0.19	0.15	0.05	0.18	0.48	0.49	0.44	0.36	0.32	0.22	0.13
Mar-May	0.14	-0.03	-0.05	-0.16	0.00	0.34	0.31	0.20	0.06	0.01	-0.05	-0.07
Apr-Jun	-0.20	-0.34	-0.34	-0.27	-0.07	0.12	0.05	-0.13	-0.31	-0.38	-0.32	-0.27
May-Jul	-0.28	-0.25	-0.31	-0.30	-0.25	-0.13	-0.20	-0.36	-0.49	-0.54	-0.36	-0.31
Jun-Aug	-0.16	-0.23	-0.24	-0.29	-0.24	-0.09	-0.12	-0.26	-0.40	-0.41	-0.37	-0.30
Jul-Sep	-0.11	-0.18	-0.15	-0.20	-0.18	-0.04	-0.09	-0.20	-.334*	-.300*	-0.29	-0.23
Aug-Oct	-0.04	-0.22	-0.21	-0.21	-0.18	0.02	-0.02	-0.10	-0.25	-0.21	-0.26	-0.18
Sep-Nov	0.03	-0.14	-0.17	-0.12	-0.11	0.12	0.06	0.04	-0.13	-0.09	-0.10	0.02
	SIP3 Gore											

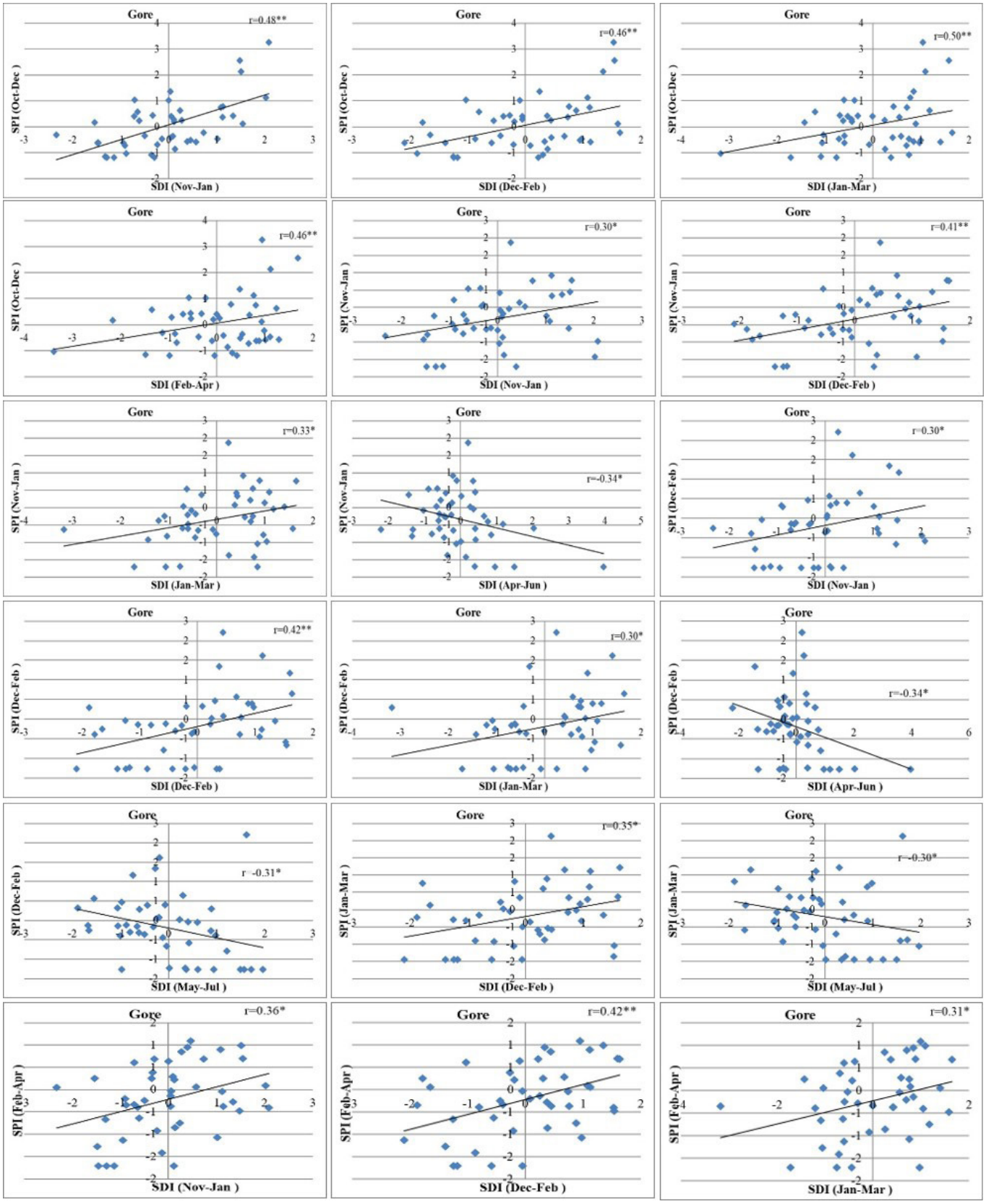

Figure 4. The Correlation between SPI for Gore and SDI for Dongola at 3 months

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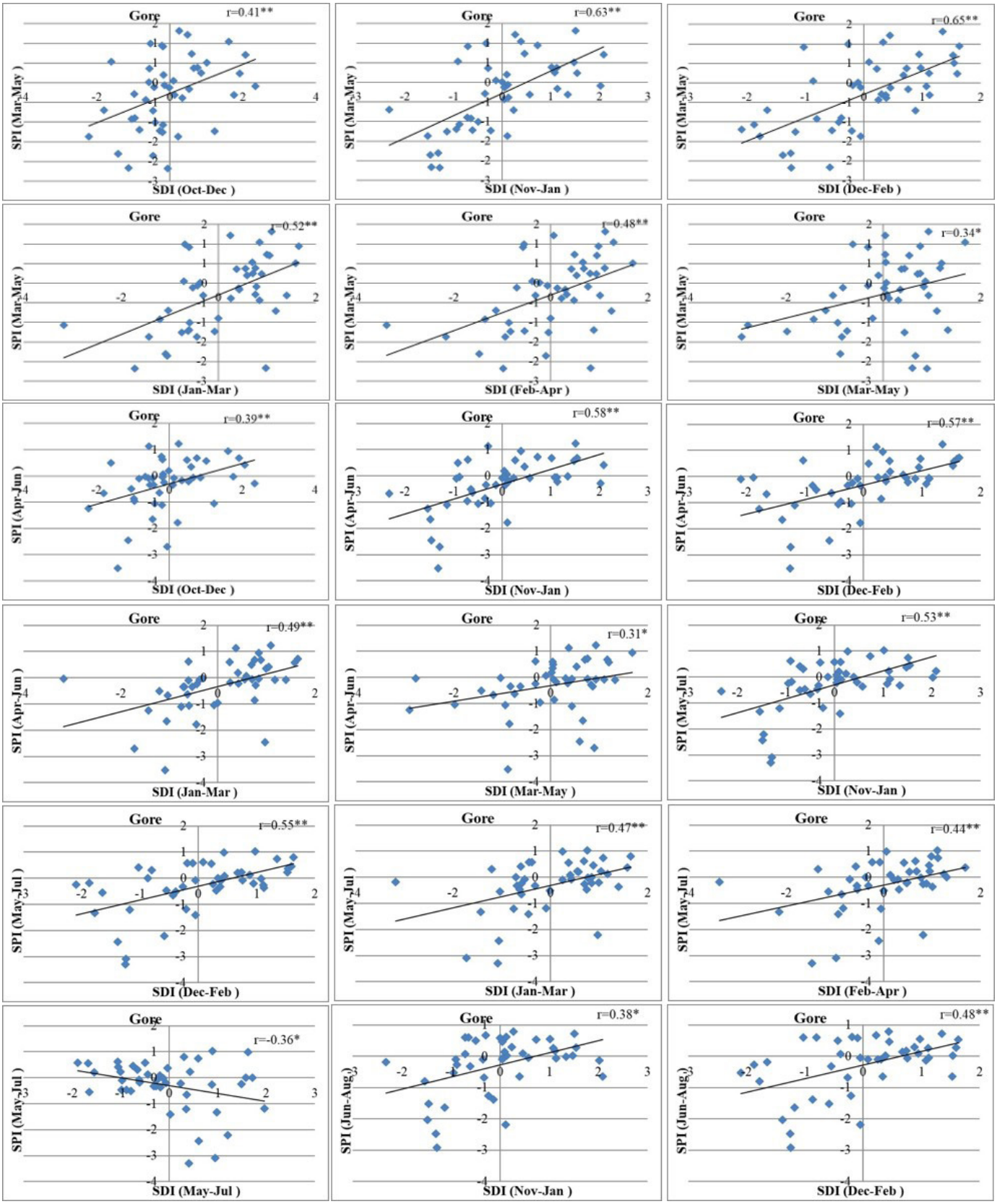

Figure 4. continued. The Correlation between SPI for Gore and SDI for Dongola at 3 months

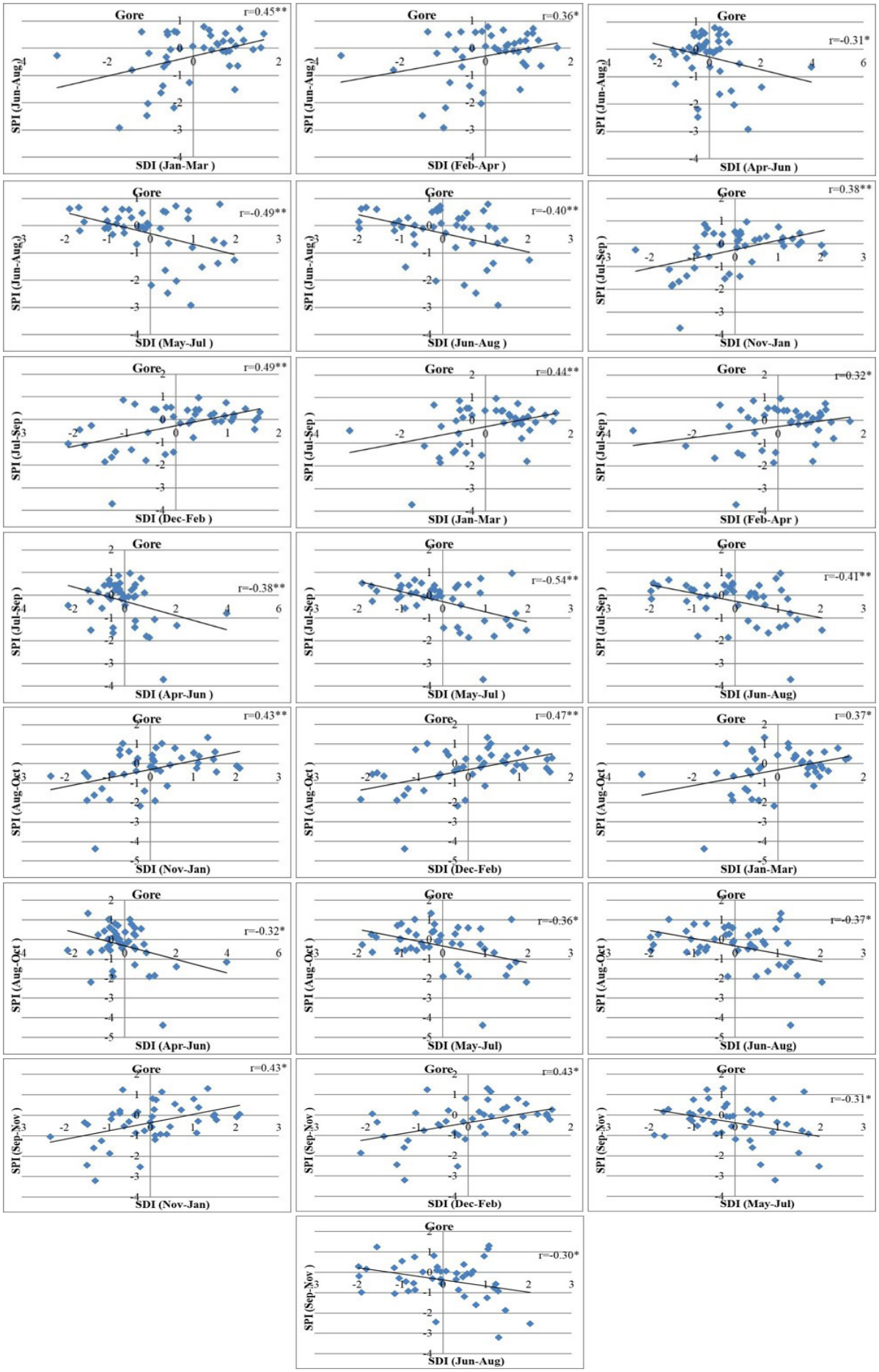

Figure 4. continued. The Correlation between SPI for Gore and SDI for Dongola at 3 months

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5. Conclusions

- Ethiopia has a climatology that varies from hot, semi-desert to mild and humid. According to the distributions of temperature which vary from north to south and increases towards the southeast region and decreases towards the central part, the climate varies mostly because of the altitude.

- There are three seasons in Ethiopia for precipitation distributions: Kiremt is the main rain season from June to September, Bega is the dry season from October to January, and Belg is the minor rainy season from February to May.

- After analysis of SPI and SDI from monthly values of SPI collected from the five stations located on the Blue Nile Basin (Addis Ababa, Bahar Dar, Debre Markos, Gondar and Gore) and SDI of Dongola, Dongola is more affected by the drought in Bahar Dar, Debre Markos and Gore.

- Pearson's correlation coefficients between each SPI and SDI intervals at different time ranges (for 1, 3, 6, 9, and 12 months) found some significant correlations (at 5% and 1% level of significance) while some were non-significant.

- The frequency of a statistically significant correlation is moderate in case of a monthly scale, where it reaches its maximum at 3 months scale, followed by 6 months scale, and less frequently at 9 months scale and not significant at 12 months scale.

- Results demonstrated a correlation exists between SPI, as a meteorological index, and SDI, as a hydrologic drought index.

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Thailand's maize seed market structure, conduct, performance

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Seed is one of the fastest-growing industries in the agricultural sector. Thailand's maize seed industry is one of the most developed and most advanced compared to other developing countries largely because of the country's programs of public and international organizations (i.e. Rockefeller Foundation, CIMMYT, USAID) carried out in the early years that included establishing the infrastructure for research and promoting the role of the private sector. Long-term investments in research and development by private companies accelerated the expansion of the industry. The success of the maize seed industry gives the basic rationale for this paper: learn lessons from it by analysing its structure, conduct and performance to provide recommendations for seed business development and policy recommendations for Thailand to become the leader in the region. The findings suggest that the maize seed industry in Thailand is oligopolistic and moderately concentrated. The business conduct of maize seed firms is pricing and product differentiation with customized varieties that are suitable to segmented markets. The business performance of the firms suggest that large multinational companies have a stronger market power than the local ones because of their strong capacity for product innovation. Nonetheless, small local companies can still profitably participate in the oligopolistic competition environment by effectively generating sales revenue using public varieties or through licensing. It is suggested that policies that enable local companies to strengthen their research capacity are needed to elevate their competitiveness. This would contribute to the sustainable development of Thailand's maize seed industry.

1. Introduction

Thailand is the third largest seed exporter in Asia (International Seed Federation, 2016), and maize contributes to the largest share of exports. The export value of maize seed from Thailand was about 43.8 million USD, topping all the other crops. Maize seed is exported to several countries in the region including Indonesia, Pakistan, Sri Lanka and Vietnam. The export volume in 2018 was more than 24 million tons valued at about 73 million USD (Thai Seed Trade Association, 2019). The privatization, in 1991, of hybrid maize seed production and distribution stimulated long-term commitments of investment in research and development (R&D), particularly from multinational companies. The success of maize seed industry development has motivated the Government to position Thailand as the Seed Hub of the region. In 2006,

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the National Center for Genetic Engineering and Biotechnology (BIOTEC),established the Thailand Seed Cluster, which harnessed science and technology to promote the production of high quality and higher value seed. The goals of this program are (1) to provide farmers with good quality seed, (2) to increase the number and income of seed-producing farmers, and (3) to promote the seed industry's role in developing and exporting Thai-owned brand-name seeds. The Seed Cluster strategic plan was set in two phases: 2007–2011 and 2011–2016 (National Center for Genetic Engineering and Biotechnology, 2007; National Science and Technology Development Agency, 2011). Its components included (1) generating sustainable germplasm management, (2) using biotechnology (particularly molecular breeding) for crop improvement through a cooperation with the private sector, (3) developing disease diagnostics and providing support to small seed producers for high-value seed production, and (4) developing seed coating technology from natural products. An analysis of the seed industry carried out by the National Biotechnology Policy Committee under the Seed Cluster strategic plan suggested that Thailand had a high potential to become the region's leader in seed industry. This prompted the government to include the seed industry among the priority industries for promotion.

In 2013-2014, the Ministry of Agriculture and Cooperatives also set up the Seed Hub Project to promote research and production for tropical plant seed. The project also aims to produce sufficient quality seed, particularly of field crops and vegetables, for domestic use and export. The hub's strategic plan included promoting public-private partnership and increasing public support to farmer groups and small local enterprises. For example, the maize germplasm network has engaged private companies, public universities, the Department of Agriculture (DOA) and the National Corn and Sorghum Research Center (NCSRC) in the collection, characterization, and evaluation of genotype and phenotype and multiplication of seed. One of the public-private partnership activities was the Public-Private Yield Trial (PPYT) program, a multilocation field testing of maize varieties with the participation of public institutions, such as DOA, and private companies (Richmond, 2013).

Despite the success of the maize seed industry, which was chosen to be a prototype crop for the Seed Hub project, there has been no significant advancement in the seed market. Small local seed business still has limited R&D capacity and lacks advanced technology. The lack of a biosafety laws and limited access to genetic materials of crops not indigenous to Thailand have hindered industry progress. Furthermore, investment in basic infrastructure such as institutional arrangements for human capacity building and modern agricultural technology, both by public and private sectors, is insufficient to drive Thailand to become a centre for seed industry (Isvilanonda, 2017).

The structure of the maize seed industry in Thailand has changed over time, from one consisting of several local small businesses that multiplied seed varieties developed by public institutes, to one with a few large companies dominated by consolidated multinational enterprises (Brown et al., 1985; Setboonsarng et al., 1991). The concentration of maize seed industry through merger and acquisition can be observed not only in the global market but also in developing countries (Fernandez-Cornejo and Just, 2007; Howard, 2009; Spielman et al., 2014; OECD, 2018). In the Structure, Conduct, Performance (SCP) model, market concentration is usually linked to firm behaviour (conduct) and industrial performance (Setiawan et al., 2013; Stiegert et al., 2009; Weiss, 1991). While increasing market power could negatively influence market efficiency and the benefits accrued by farmers and consumers, it also implies economies of scale in R&D (Fernandez-Cornejo and Just, 2007). Spielman et al. (2014) found that India's seed industry is concentrated, and the private companies have a significant role in varietal improvement. Public institutes, on the other hand, play an important role in providing traits, which attract little interest from the private sector. Similarly, in Thailand downy mildew resistance in tropical maize was developed by public institutes with the support of international organizations in the early 1970s; the trait is still used in the breeding programs of several seed companies (Napasintuwong, 2017).

While performances (i.e. profitability) of firms in concentrated markets may be expected (Stiegert et al., 2009), others have suggested it is unclear that performance, such as product price and innovation of the seed industry, results from market concentration (Fulton and Giannakas, 2001; OECD, 2018). Cromwell et al. (1992) suggested that seed industry performance could be evaluated both at firm-level and national-lev-

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el, such as distribution and availability of good quality seed. Measurement of performance, competition and innovation in maize seed industry can be used to shape national agricultural growth strategies, set public research priorities, design private innovation incentives, construct public input provision programs, and encourage maize seed industry development and productivity-enhancing technology adoption (Spielman and Kennedy, 2016). The adoption of hybrid maize in Thailand has reached saturation level (Poolsawas and Napasintuwong, 2013); there remain the important questions of whether current market structure provides incentives for private companies to perform business conduct such as innovating new improved varieties and whether performance of small local companies is competitive compared with large multinational companies. Furthermore, given the increasing mergers and acquisitions in global seed companies, small local seed companies may face more challenges in developing competitive varieties with their limited access to international germplasm and limited capital.

A few studies have explored the business environment of Thailand's seed industry (Brown et al., 1985; Napasintuwong, 2017; OECD, 2018; Setboonsarng et al., 1991), but because of limited data availability, none of them focused on business performance of seed firms. This paper aims to analyse the seed industry with focus on maize and on the differences between multinational firms and local companies. Its main contribution is to provide key information on the industry structure, firm-level business conduct and performance of seed companies. The results can be used to design appropriate policy support for small local companies in the development of the seed industry of Thailand as well as other developing countries.

2. Methodology

The scope of maize seed industry in Thailand was given to field maize, excluding waxy corn and sweet corn. The companies included were private companies that not only multiply, distribute and market seeds (trading firms) but also engage in R&D or have some research programs and participate in technology development (i.e. technology firms). Their extent of research involvement could range from participating in field trials of public varieties to fully engaging in breeding, varietal and seed technology development.

Structure, conduct, performance framework

There are several indicators suggested by Lipczynski and Wilson (2001) and Carlton and Perloff (2015) to analyse market structure, conduct and performance. Due to limited publicly available data, industry experts from the Thai Seed Trade Association (THASTA), Seed Association of Thailand, NCSRC, and DOA were interviewed to obtain information on industry environment and firms' business practices. The information complemented the quantitative analysis.

Market structure

Market concentration, a measure of uneven distribution of market shares of firms in an industry, is one of the most common indicators used in empirical studies. Concentration Ratio (CR4) (or CR8) and Herfindahl-Hirschman Index (HHI) are often used to illustrate market structure and the market power of seed industry (Spielman and Kennedy, 2016; Fernandez-Cornejo and Just, 2007; Morris, 1998; OECD, 2018;). Because sales and volume of seed sold by individual companies in Thailand are not publicly available, seed sales volume (Aungsuratana et al. 2012, cited Department of Business Development) was used to estimate CR4 and HHI. The larger the concentration ratio of the four largest firms, the lesser or lower the level of competition. The interpretation of market concentration by HHI is based on the U.S. Department of Justice's Horizontal Merger Guidelines (U.S. Department of Justice, 2018). A market is considered moderately concentrated if the HHI is between 1,500 and 2,500 andhighly concentrated if it is above 2,500.

$$CR_4 = \sum_{i=1}^{4} S_i$$

where Si is the market share of the four largest company i.

$$HHI = \sum_{i=1}^{N} S_i^2$$

where Si is the market share of the company i and N is the number of companies.

Additionally, product similarity and differentiation are used to describe the structure of the maize seed

market. Production information from the Multilocation Public-Private Yield Trial (MPPYT) program of multiple geographical location field trials were used to compare product characteristics. The MPPYT is a cooperative hybrid corn trials program between public sector represented by Kasetsart University, National Corn and Sorghum Research Centre (NCSRC), and Department of Agriculture (DOA) and private seed companies (FAO, 2013). It covers pre-commercial and commercial elite hybrids voluntarily submitted by private seed companies to jointly, without bias, evaluate and compare maize hybrids available for commercialization (Richmond, 2003). The MPPYT conducted by the National Corn and Sorghum Research Center (NCSRC) have provided the maize seed industry with trusted results since 1987. Barriers to entry and exit and enabling environment are also discussed.

Business conduct

Seed business conduct included in this study covers product promotion and pricing strategy, price discrimination, collusion, quality assurance and product compensation (Pepall et al., 2008; Carlton and Perloff, 2015). Maize seed prices were obtained from an unpublished nation-wide market survey of two multinational seed companies. The information was provided through personal request. Price data of small local seed companies and of public suppliers were obtained from interviews with owners of seed companies and public officers. All seed prices are recommended prices for agrodealers and did not include discounts.

Business performance

Profitability is commonly used to measure business performance. In addition, it is assumed that seed companies' objectives include their market power or ability to control market power, efficiency and growth of business operation. Due to limited data especially of small firms, other performance indicators such as growth in market share and market value addition, customer and stakeholder satisfaction could not be generated. Seed companies' business data were obtained from the Department of Business Development (2018).

Market power: Price-Cost Margin (PCM)

If data on marginal cost cannot be obtained from company financial reports, Price-Cost Margin (PCM) and accounting rates of profit on capital can be used to measure profitability of the companies (Lipczynski and Wilson, 2001). Lerner index is conceptually used to measure the monopolistic power. Given that the Lerner index $= \frac{P-MC}{P}$, and on the assumption that average costs are constant, the price-cost margin (PCM) is equal to the Lerner index. The PCM is defined as the ratio of profit to sales revenue and can be expressed as

$$PCM = \frac{P-AC}{P} = \frac{P \cdot Q - AC \cdot Q}{P \cdot Q}$$

where P is price, Q is quantity ,and AC is average cost. The larger the price-cost margin, the greater the company's ability to raise prices above average costs, which implies higher monopoly power.

Efficiency: Current Asset Turnover Ratio

The current asset turnover ratio implies the efficiency or how well a company generates sales revenue from its current assets.

$$\text{Current Asset Turnover Ratio} = \frac{Revenue}{Current\ Assets}$$

Profitability: Accounting Rate of Profit

The accounting rate of profit may be used as a proxy for profitability when the data to calculate the economic rates of return are limited. Profitability reflects a firm's ability to generate returns. The accounting rate of profit on capital is defined as follows (Scherer and Ross, 1990):

$$\text{Accounting Rate of Profit on Capital} = \frac{Accounting\ Profit + Interest\ Payments}{Total\ Assets}$$

Growth: sales growth, total asset growth

Business growth demonstrates a firm's ability to increase its size. Even at the same profitability level, increasing its size will increase the firm's absolute profit. A larger size can also bring economies of scale and market power, leading to an increase in future profitability. The growth is calculated from 2012, the year the market shares are used to calculate market concentration, to 2018. For companies that had been restructured or taken over during this period, the corporate data in 2012 were of the old companies.

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Sales growth =

$$\frac{[Net\ revenue\ 2019 - Net\ revenue\ 2012]}{Net\ revenue\ 2012} * 100$$

Total asset growth =

$$\frac{[Total\ asset\ 2019 - Total\ asset\ 2012]}{Total\ asset\ 2012} * 100$$

3. Results and discussion

Market structure

Market concentration

The market structure of the maize seed industry in Thailand can be characterized as two-tiered. The first tier consists of a small number of multinational companies engaged in the upstream segment i.e. germplasm collection and conservation and breeding program to multiply, distribute and market seeds in domestic and international markets. These include five leading multinational companies. Four of them, Monsanto, Syngenta Seeds, Pacific Seeds, and Pioneer Hi-Bred, are subsidiaries of foreign companies. Only Charoen Pokphand (C.P.) Seeds[1] is a Thailand-parent multinational company. The second tier consists of many small local companies supplying specialised products. Fulton and Giannakas (2001) found that many local seed companies that developed seed for a specific geographical market had been taken over by multinational companies. The latest acquisition was in early 2014, when Seed Asia, a local seed company that had a breeding program, was taken over by Limagrain in early 2014.

The CR4 and HHI calculated from market share obtained from Aungsuratana et al. (2012) (Table 1) were 76% and approximately 1,700, respectively. This suggests that the maize seed market is oligopolistic and moderately concentrated. Using the expert elicitation method of most adopted varieties in 2013/2014 cropping year, Napasintuwong (2017) found that CR4 and HHI of maize seed industry were 65% and 1,230, respectively. A more recent analysis of data, in 2016, found that CR4 and HHI of maize seed market in Thailand were 91% and 2,244, respectively (OECD, 2018). Although these studies use different sources of data and methods of obtaining the estimates, the results are consistent: both suggest that Thailand's maize seed market is oligopolistic and moderately concentrated. Evidently the global seed market has become more concentrated over the years, which can be attributed to the mergers and acquisitions. In 2015, Pacific Seeds was taken over by Advanta Seeds and in 2016, Monsanto was bought by Bayer and Syngenta Seeds by China National Chemical. Although these acquisitions did not change the number of key multinational companies in Thailand, their access to technology and broader germplasm collection would have boosted their capacity to compete in the local and international markets. Furthermore, although concentrated markets do not necessarily imply the

Table 1. Sales and market share of leading maize seed companies, 2012

Company	Sales (ton/year)	Market share (%)
Monsanto (Thailand)	4,718.80	23.500
Charoen Pokphand Seeds	4,216.80	21.000
Syngenta Seeds	3,202.80	15.950
Pacific Seeds	3,182.70	15.850
Pioneer Hi-Bred	2,841.30	14.150
Others	1,917.60	9.550
Total	20,080.00	100.000

Note: Pioneer Hi-Bred is a subsidiary of Dupont Pioneer

[1] Charoen Pokphand maize seed division was part of Charoen Pokphand Group, a large agro-conglomerate. It was operated under C.P. Seeds and moved to Charoen Pokphand Produce which consists of several businesses including fertilizers and crop protection chemicals.

presence of market power, they may create higher barriers to entry and impose a cost disadvantage to potential entrants and existing firms (Maisashvili et al., 2016)

Product differentiation/similarity

Table 2 compares the characteristics of pre-commercial and commercial maize hybrids in the market in 2018 (National Corn and Sorghum Research Center, 2019). The upper section of the table are the results of the MPPYT. Varieties were selected by participating companies as the best hybrids about to be released or have been released to the market. The varieties submitted by Kasetsart University were also available for licensing to local companies. The performance of the seeds from the MPPYT is apparently better than farmers' field trials, and seeds from the five largest multinational companies tend to outperform those of the local companies and new foreign subsidiaries.

Nakhon Sawan-3 (NS3) developed by DOA was a good representative of a commercial public maize variety. It is considered competitive to privately developed varieties (Napasintuwong, 2017). DOA gave the authorization to local companies to non-exclusively produce NS3 for commercialization so that numerous local trading companies, that do not engage in any R&D, have gone into the production of NS3 seeds with the technology transferred from the public sector. Although farmers have a wide range of seed products under different brand names and trademarks, the range of product differentiation is much narrower because the same or similar products are marketed under different brand names by small local companies. The comparison of varieties across seed companies reveals that product characteristics vary from yield and number of ears, to resistance to diseases, which resulted in performance ranging from rotten ear to farmers' preferred traits, such as low lodging and high standing, low moisture content and high shelling percentage. Each company tended to develop varieties suitable to specific market segments such as uplands, dry zones, drought-prone, downy mildew–prone (most private varieties are susceptible to this disease), and preferred size of seed for planting machines, which affect farmers' adoption choices. Generally, private varieties perform better than the public varieties especially on yield and resistance to diseases but products are suitable to specific market segments such as climatic condition, geographical area, season, and harvesting technique (Napasintuwong, 2017); however, the public varieties (especially NS3) are more resistant to downy mildew disease and well-adapted to broader market segments.

The role of R&D, both by private companies and public institutes, is important to the development of seed business (Fernandez-Cornejo, 2004) and would be important for creating competitive products. As the seed market becomes increasingly consolidated, it could result in lower investments in traits such as varieties adapted to local conditions (Howard, 2015), and negative impacts such as limited farmers' choices of varieties (Schimmelpfennig et al., 2004). Thus, public support plays an important role in promoting product innovations and differentiation of products to meet farmers' needs, such as providing access to public germplasm or open source seeds, which discourage restrictions on intellectual property protections (Luby et al., 2015). Licensing, either exclusive, partially exclusive or non-exclusive, is one of possible models to promote private-private agricultural research (Fuglie and Toole, 2014). The result from this study shows that small local companies could remain relatively competitive in the same market with larger multinational firms and provide seeds needed for broad local adaptation, as in the case of NS3.

Barriers to entry and exit

A critical barrier to entry and exit is the initial investment. Technology in seed business, especially crop improvement, demands high investment cost. During the early stage of seed market privatization in the late 1970s to early 1980s, the initial investments in establishing research stations of multinational seed companies were about two to five times larger than that of the Thai-parent multinational company (presently, Charoen Pokphand Produce) (Suwantaradon, et al., 1989). Other key barriers to entry were research funding, human capacity in varietal improvement and access to germplasm. The multinational companies have a greater advantage over the small local companies in terms of capital and broad collection of genetic materials (Napasintuwong, 2014). During the 1980s, the early entrants also developed partnerships and strong linkages with international organizations

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Table 2. Characteristics of maize seed varieties, 2018

Company	Variety	Yield (kg/ha)	Height (cm) Plant	Height (cm) Ear	Plant stand (number)	Rotten ear (%)	Ears/100	Moisture (%)	Shelling (%)
From cooperative hybrids corn yield trial from 12 locations									
5 Largest multinational companies									
Charoen Pokphand	TSF1603	10,042.3	215.9	128.5	49.6	4.6	97.9	25.8	82.7
Charoen Pokphand	TSF1708	9,560.5	225.7	133.9	50.4	3.2	96.8	26.4	81.3
Charoen Pokphand	TSF1717	8,547.5	219.3	130.6	49.9	3.8	95.7	25.6	82.4
Charoen Pokphand	CP888	7,817.3	224.5	148.9	49.7	3.7	106.2	23.0	81.4
Monsanto	DK9950C	10,197.6	226.5	138.5	49.8	4.2	100.7	26.5	83.6
Monsanto	DK9919C	9,712.4	220.1	133.1	51.2	3.8	98.7	25.2	81.4
Pacific Seeds	PAC164	9,945.8	207.8	126.1	50.1	4.0	97.0	26.5	85.6
Pacific Seeds	PAC139	9,455.6	202.3	125.6	49.7	6.7	96.5	26.0	85.2
Pioneer	P4084	9,749.5	242.6	134.6	50.3	6.3	99.1	25.1	82.1
Pioneer	P3875	9,400.1	234.1	136.6	50.1	10.2	97.3	25.9	80.3
Pioneer	P3582	9,345.3	236.0	135.0	50.1	6.7	95.2	26.9	80.3
Syngenta Seeds	ST6275	9,949.6	225.8	147.0	50.4	6.0	100.6	25.8	84.3
Syngenta Seeds	STG246	8,560.8	233.9	150.3	51.1	3.1	97.6	25.8	81.3
Avg of multinational companies		9,406.5	224.2	136.1	50.2	5.1	98.4	25.7	82.5
Local and new foreign subsidiaries									
Fertilizer and Bioseeds	BD330	9,688.7	234.8	142.8	50.4	9.5	100.5	25.8	80.0
Fertilizer and Bioseeds	BD51450	8,890.7	203.9	117.3	50.4	3.0	98.9	26.3	82.7
Limagrain	LG36.769	9,327.4	220.4	136.2	50.8	3.9	94.9	27.0	81.9
Limagrain	LG38.778	8,804.4	229.6	134.8	50.8	3.7	98.2	25.7	80.5
Northern Seed	NTSX-	8,362.4	220.6	132.9	49.5	9.5	97.4	25.5	78.6
Northern Seed	NTSX-3S68	7,493.9	204.8	129.2	49.1	6.8	98.3	25.5	79.4
World Seeds	HB65	8,367.9	219.4	135.3	49.8	5.5	93.1	25.7	79.0
World Seeds	HB149	7,814.0	231.4	142.2	48.3	8.3	84.6	26.5	81.1
Avg of local companies		8,593.7	220.6	133.8	49.9	6.3	95.7	26.0	80.4
Public									
Dept of Ag	NS3	7,843.3	214.4	135.3	49.4	3.0	99.4	23.5	80.8
Avg of public		7,843.3	214.4	135.3	49.4	3.0	99.4	23.5	80.8
From 30 locations of farmers' field trials, 2018									
5 Largest multinational companies									
Charoen Pokphand	CP888	5,834.1	214.5	120.0	48.3	3.5	45.8	19.8	83.7
Syngenta Seeds	ST6275	7,492.8	215.5	116.9	50.6	2.1	48.4	21.1	87.1
Syngenta Seeds	STG246	7,023.3	218.0	118.9	50.5	4.2	47.2	22.1	85.1
Avg of multinational companies		6,783.4	216.0	118.6	49.8	3.2	47.1	21.0	85.3
Local and new foreign subsidiaries									
Fertilizer and Bioseeds	BD330	7,115.6	218.3	114.8	50.8	4.5	48.4	21.7	84.0
Fertilizer and Bioseeds	BD51402	6,501.5	204.3	111.1	50.4	3.3	47.9	19.9	86.7
Goldconda Asia	GT822	6,884.8	199.2	107.5	49.7	4.1	45.2	21.4	86.6
Goldconda Asia	GT722	6,771.3	202.2	108.7	48.9	5.1	44.5	21.7	85.6
KWS Seeds	KWST7013	7,104.8	210.6	109.3	49.5	3.8	43.6	21.7	87.1
KWS Seeds	KWST7014	6,644.3	213.3	117.0	48.4	3.9	44.9	21.1	86.5
KWS Seeds	KWST306	6,020.2	223.6	113.0	46.0	4.1	42.6	19.3	83.0
Limagrain	LG38.778	7,207.8	212.1	120.0	49.8	3.8	47.4	21.8	84.5
Limagrain	LG36.769	6,401.5	212.8	111.6	49.6	4.1	44.6	23.0	85.2
Northern Seeds	NTSX6A28	6,255.3	208.0	105.1	48.5	4.8	43.4	21.6	82.9
Northern Seeds	NTSX9S68	6,172.1	199.9	103.6	48.1	3.3	44.2	20.8	84.4
Avg of local companies		6,643.6	209.5	111.1	49.0	4.1	45.1	21.3	85.1
Public									
Dept of Ag	NS3	7,843.3	214.4	135.3	49.4	3.0	99.4	23.5	80.8
Kasetsart Univ	KSX6110	8,913.7	228.3	150.5	49.5	6.5	94.4	27.1	79.1
Kasetsart Univ	KSX6015	8,131.5	208.1	132.0	49.9	2.9	93.9	24.9	81.5
Avg of public		8,296.2	216.9	139.3	49.6	4.1	95.9	25.2	80.5

Source: National Corn and Sorghum Research Center, 2019

(i.e. CIMMYT, USAID), and public organizations (i.e. DOA, Kasetsart University) in breeding, yield trials, and extension (Brown et al., 1985; Ekasingh et al., 1999). These relationships would have favoured their business operations through their influences on regulations on seed standards and registration of

new varieties that make it difficult for new entrants especially small local companies to enter the market. On the other hand, as the market became consolidated by multinational companies, the barriers to entry did not pose much of a challenge for large multinational seed companies. For example, KWS, a large German seed company entered Thailand's maize seed market in 2015 when major maize seed companies have been operating for decades. Earlier, in 2014, Limagrain, a large French seed company, took over Seed Asia, a local company.

Large seed companies are often vertically integrated (e.g. with feed) and horizontally integrated (e.g. with agrochemicals). The integration can create more market power and stronger barriers to entry. For instance, seed companies that also have a feed manufacturing business can reap a higher market share from their seed products. Charoen Pokphand Produce used to buy higher price maize grain produced from their seeds (visibly orange) thus gaining more market share. Currently, there is a government program to promote maize cultivation after rice harvest in the dry season. Large seed companies that have an integration and those that have a business link with feed manufacturers that arrange to buy maize grains from their seed sales, are especially considered for government support, leaving other companies without access to the same support.

Enabling environmental regulations

Thailand's Board of Investment (BOI) has been providing incentives for companies that conduct research using biotechnology or engage in plant breeding, by providing 8-year and 3-year corporate tax exemption, respectively (Thailand Board of Investment, 2019). While large companies employing biotechnology in plant breeding can benefit from this support, small companies with limited capital but involved in plant breeding can also benefit from the support, although to a lesser extent. This policy gives both small and large companies the opportunity to enter the seed industry, which can make the industry more competitive.

Important regulations like the Plant Variety Act (PVA) or Seed Act and the Plant Variety Protection Act (PVP) are shaping the structure of the industry. The PVA regulates the quality of seeds at all stages, from production to sales and distribution, including imports and exports. Registration of varieties is required for all commercial collections and sales of maize seeds, and only protects the rights to use the varietal names and trademarks. The production and sale of seeds of regulated plant varieties are subject to minimum quality standards, such as purity and germination rates for maize (98% and 75%, respectively) (Ministry of Agriculture and Cooperatives, 2006). The penalty for selling substandard seed is either a one year of confinement, a 2,000 THB fine or both. Enforcement, however, is non-stringent, which practically consigns the small local companies to the low-quality market segment. As it had been observed, for example, NS3 is sold at a much lower price by small companies than large companies with better quality seeds (discussed in the following section).

The PVP protects the rights-holders of newly developed plant varieties (following distinctness, uniformity, and stability or DUS principles) by giving the sole right to produce, sell or distribute, import, export, or possess them for the above mentioned purposes. However, it only protects varieties that have been developed after the regulation came into effect in 1999. Seed imports purely for the purpose of registering PVP are not considered R&D and the subject plant variety must be grown in Thailand for examination. Seed imports for the purpose of trials still require a permit, which has been a major obstacle due to the lack of cooperation between the authorities. It was found that most commercial maize varieties are not registered under PVP. This may be the result of the new varieties developed by large multinational companies being in the market for only a few years before these are replaced with newer products. In addition, for PVP to be granted, imported seeds for research must fulfil both PVP and PVA requirements, which invalidates the varieties bred and developed outside of Thailand by foreign companies.

Thailand's maize seed industry is oligopolistic, but product differentiation and market segmentation have lessened the market power of large companies, especially with public support in providing the parental lines without a royalty fee to small local companies.

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Business conduct

Price discrimination

Price discrimination occurs when firms with monopolistic power, who know their demand curve and the willingness-to-pay of consumers, maximize their profit by setting different prices. The third-degree price discrimination or group pricing happens when firms quote the same price per unit to all consumers within a particular group, and consumers in a particular group decide how much to buy at the quoted price (Pepall et al., 2008). It was found that the same product variety is sold at the same price across groups of farmers regardless of their location. However, in some cases, such as during the drought season when farmers replant their crops and during the second cropping season (dry season), some companies lower the price to increase their market share. Furthermore, a quantity discount is given to dealers based on sales volume and on different credit period.

Table 3 shows hybrid maize seed prices by product groups. The grouping was constructed by market analysts of multi-national seed companies. The products in competitive pricing are lower in performance such as yield and offered at lower prices. Standard products are products that are suitable for broad market segments and usually have been in the market for a period of time. Premium products are products that offer farmers superior characteristics, such as long-period standability, high yielding, drought resistant and disease resistant; these are for specific market segments that are willing to pay a higher price. (In this group, seed treatment such as coating to prevent fungus and increase germination and yield are sold at premium price). The last group, newly released varieties, is sometimes priced relatively low to gain market recognition and then priced higher after one or two seasons. Local companies generally offer lower performance products at lower prices than multinational companies. There are numerous local companies that do not conduct any breeding program nor sell licensed products from other companies or private breeders. These companies are typically very small and depend solely on public varieties. NS3, for example, is sold at different prices and under different trademarks. The price of NS3 sold by the DOA is 70 THB/kg while prices of NS3 set by other companies typically depend on the quality of products, such as purity and germination rate. This pricing strategy suggests that farmers are segmented based on their production environment and their willingness to pay for quality. Most seed companies offer differentiated products at different prices for different market segments. The cost of seed is only about 10-20% of the cost of maize production[2], and the output depends heavily on the characteristics of varieties. Farmers who are willing to pay a higher price are those who expect higher product quality and yield. This suggests that competitive pricing may be a good market strategy for companies that offer lower product quality, although monopolistic pricing may also be another market strategy, especially by leading companies that have large market shares and a high capacity for product innovation.

Quality assurance and product compensation

As mentioned earlier, the PVA sets minimum standards for seeds. While large multinational companies operate a production control system from seed production to seed processing, small local companies have a weaker control system resulting in lower quality and sometimes sub-standard products. The standards such as germination rate of some large companies are set above the PVA standard to position their products in a premium market segment. When claims of poor quality (such as low germination rate) are lodged against the products of large companies, they usually take responsibility by compensating their customers fully or partially, depending on the situation, to secure customer loyalty. Small companies typically do not provide any compensation or acknowledge complaints about poor quality products; sometimes they also change the product name and packaging without any change in quality. Their strategy is to gain as much sales as possible without regard to long-term market loyalty.

Collusion

Collusion in the maize seed market is not obviously observed as products are differentiated. Nevertheless,

[2] Estimated based on maize seed market prices and seed rate of 18.75 kg/ha, and a survey of the cost of maize production by the Office of Agricultural Economics, 2013.

a group of small producers in Phrow district in Chiang Mai province producing NS3 agrees to set the price of their products at 120 THB/kg or higher. The member producers of this group benefit from complying with certain agreements such as sharing market information and facilitating PVA registration, which may be difficult for small companies to handle. The price is set so that the group can ensure quality control and that substandard seeds are not sold at a lower price in unauthorized markets.

Industry performance

The PCM reflecting the market power of the firms reveal that generally, the five largest multinational companies have more market power than the local companies or new subsidiaries (Table 4). Among the leading companies, Charoen Pokphand Produce has less market power than the foreign subsidiaries. From broader genetic materials, foreign companies gain a greater advantage over the local companies in developing improved varieties and superior products. Monsanto, Syngenta Seeds and Pacific Seeds may be considered innovative firms as they have released new varieties and filed for plant variety protection (Plant Variety Protection Office, 2019). Monsanto also licenses their hybrids to other companies such as Charoen Pokphan Produce. On the other hand, Limagrain, a large French seed company that took over Seed Asia in 2014, currently has a very small market share and much less market power than other local companies. This could be because the synergy of the two companies has yet to manifest, and their development of new products is behind the leading companies.

Typically, local companies depend highly on public variety development (NS3) and engage in R&D at a much lesser extent than large multinational companies. Goldconda Asia and World Seeds have participated in the MPPYT (Table 2), implying that the companies also have conducted R&D. Although their market power is lower compared to foreign multinational companies, their PCM is better than other small local companies. In addition, as mentioned in the market structure section, the maize seed industry is segmented, and companies' pricing strategy shows differentiated products. Assuming that local companies operate in the same market segments, Golconda Asia has the largest market power in these segments among local companies and even larger than some leading companies in other segments.

The accounting rate of profit on capital, which is the representation of profitability, shows that although local companies have less market power, their profits are satisfactory. Limagrain, however, is not profitable. Given that it has promising growth in assets, the company may take time after acquisition to bring the products from the application of their knowledge and advanced technology to the requirements of the Thai market. Companies that have high technological capacity appear to have relatively high profitability and strong market power.

Based on current asset turnover, companies can effectively generate sales from current assets by relying on public R&D and good public varieties, or by buying licensed products from large companies (e.g. Charoen Pokphand Produce licensed from Monsanto) or from other private breeders (e.g. Premier Seeds and World Seeds). Evidently these companies have a high current asset turnover compared to other companies, but their market power is limited. In the early stage, local companies may rely on the benefits from licensed products to generate profits and accumulate total asset, but in the long run they may need to invest more in R&D and have their own competitive products. The role of DOA and NCSRC in facilitating cooperative yield trials is crucial in bridging the gap between local companies and multinational companies. The local companies can learn from this program and exploit opportunities in the market through a better understanding and use of existing technology and competitors' available products.

In addition, business cooperation between public institutes and local companies can potentially be enhanced. Public research institutes (i.e. Kasetsart University) have provided basic research outputs such as pre-commercial parental lines to local companies (i.e. World Seeds) that have limited capital to conduct full R&D. Local companies can select potential products for their segmented markets and extend the research to multi-location field trials themselves. The results of seed companies' performance imply that small local companies, although with limited market power and efficiency, can profitably compete in the market with multinational companies. Overall, the maize seed industry is performing well, generating

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Table 3. Hybrid maize seed price in Thailand, 2019

Product group	5 Largest companies	Product	Price	Small local and	Product	Price
Competitive	Charoen Pokphand	CP801	87	Goldconda Asia	GT029	120
		CP888	141	Limagrain	TF222	150
	Pacific	Pac559	120		SA282	140
		Pac129	120	Premier	Premier56	80
		Pac139	139		Permier555	135
	Pioneer	P4084	150	World Seed	3355	120
		P4124	150		3399	120
	Syngenta Seeds	NK106	137		3377	120
		NK6172	137			
Average			131.22	Average		123.13
Standard	Charoen Pokphand	CP888n	171	Goldconda Asia	GT709	177
		CP301	171		GT722	177
	Monsanto	DK9955	178	KWS	KWS2211	168
		DK9901	178		KWS7304	175
		DK7979	178		KWS8933	179
	Pacific Seeds	Pac339	192	Limagrain	LG778	175
		Pac999	185	Premier	Permier246	170
		Pac777	185		Permier518	175
	Pioneer	30B80	180		Premier515	160
		P4546	189			
Average			180.70	Average		172.89
Premium	Charoen Pokphand	CP508	183			
		CP303	183			
	Monsanto	DK9898	182			
		DK9919	187			
		DK6818	183			
	Pacific Seeds	Pac779	190			
		Pac789	195			
	Pioneer	P3582	189			
		P4546	199			
	Syngenta Seeds	S7328	189			
Average			188.00	Average		n/a
New products	Charoen Pokphand	CP639	183			
		CP640	183			
		CP640	183			
	Monsanto	DK9950	182			
	Pacific Seeds	Pac278	192			
	Pioneer	P4554	180			
	Syngenta Seeds	S6248	189			
		NK6253	192			
		NK6275	197			
Average			186.78	Average		n/a
Public variety				Dept of Ag	NS3	70
				Mae-Sot Ag Coop	NS3	120
				Phrow seed producer group	NS3	120
				Small local enterprises	NS3	60
Average						92.5

Source: Unpublished seed companies' market survey
Note: KWS Seeds entered Thailand market in 2017, and Limagrain took over Seed Asia in 2014
NS3 is sold by small companies by different brands and trademarks from 45-120 THB/kg
Average price of maize grain in September - October 2019 = 8.38 THB/kg
Bank of Thailand exchange rate Q1-Q3, 2019: 1 Euro = 35.17 THB

profits and efficiently generating returns from current assets. The market power of leading firms is higher than small firms, but considering different market segments, small firms can also acquire a high market power. This implies that the oligopolistic structure leaves room for competition for local companies. With support from government in providing knowledge and pre-commercial lines and licensing from private breeders, the local companies can generate profit, accumulate growth in sales and assets and remain

competitive in the market.

4. Conclusion

Following the success of the maize seed industry development in Thailand, the Government has set its sights at making the country the Seed Hub of the region. The analysis of the structure, conduct and performance of maize seed industry in Thailand reveals that the industry is oligopolistic and moderately concentrated. The trend of the global seed industry is towards more concentration, with mergers and acquisitions by large multinational companies. This may affect the competitiveness and performance of local companies in the future. Although local companies, so far, have been able to generate profits effectively by relying on public released varieties and licensed products, these may not be enough to sustain their profitability. Although local companies have had significant growth in sales and total asset during the past several years, it is suggested that they try to gain market recognition and profits by building up technological capability to generate competitive products, investing in their own R&D programs and taking part in collaborative research programs with public institutes. Small companies that have limited capital or new entrants may acquire licenses i.e. parental lines from research institutes to generate unique and competitive products. It is important for the government to upgrade the capacities of local companies so that they come up with innovations and produce Thai-brand name products to compete with multinational companies. The future of the Seed Hub policy depends much on the capacity of Thai companies to remain competitive in the seed market. Aside from tax incentives, the institutional arrangements to support public-private R&D can further be improved. For example, as suggested by Fugle and Toole (2014), public sector may invest in basic research and transfer technology to private companies to develop into products; other strategies such as forming a consortium consisting of small local seed companies and public institutes to jointly develop products with traits adapted to specific segments, and

Table 4. Thailand's maize seed industry performance, 2018

Company	Price-cost margin	Accounting rate of profit on capital	Current asset turnover	Growth in sales (%)	Growth in total asset (%)
5 largest multinational companies					
Charoen Pokphand Produce	0.043	0.079	1.839	97.273	84.343
Monsanto Thailand	0.124	0.116	1.265	9.735	35.193
Pacific Seeds (Advanta Thailand)	0.299	0.252	0.938	100.195	140.268
Pioneer	0.210	0.109	0.780	0.353	45.888
Syngenta Seeds	0.173	0.118	0.714	42.340	135.656
Local companies and new subsidiary					
Goldconda Asia	0.148	0.103	1.019	532.645	1,933.747
Limagrain (Seed Asia)	-0.662	-0.143	0.437	- 36.721	60.626
Premier Seeds	0.087	0.112	1.977	8,210.708	4,586.091
World Seeds	0.095	0.091	1.536	36.739	758.739

Source: Calculated from Department of Business Development (2018)

Note: Growth rates are calculated from 2012 to 2018 except for Limagrain, growth rates are from 2013 to 2018.
Seed Asia was taken over by Limagrain in 2014.
Pacific Seed was taken over by Advanta in 2015.
Monsanto was taken by Bayer in 2016.
Syngenta was taken by China National Chemical in 2016.
Goldconda Asia operated as C.M. Seeds before 2017.

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government loans and grants to support potential seed companies in building technological capacity should be considered.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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Research Paper

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The effect of edible coating with combined Thymus vulgaris extract and glycerol monostearate on oyster mushroom´s shelf life

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Pleurotus ostreatus, thymus vulgaris, coating, glycerol monostearate coating.

Shelf-life of mushrooms is very low, because of several characteristics, such as their thin epidermal structure and high respiration rates. They tend to lose their quality after harvest. Hence, mushrooms need supportive care to keep freshness. Several protective methods have been recommended. In the current study, the effect of lipid-edible coating with different doses of glycerol monostearate and thyme extract, for the extending of edible mushroom's shelf life was evaluated. After, preparation of aqueous thyme extract (TE) by the Clevenger method, the mushroom treatments were prepared with different concentrations of the glycerol monostearate (GMS) and thyme extract. The chemical composition of the extract was performed using GC-MS method. The texture tightness, colour, and weight loss were respectively, measured using the texture analyzer, HunterLab, and digital balance. The Sensory and antimicrobial evaluations were also performed during the 15 days. Analysis of the extract has detected the 23 chemical compositions with the different structures and functional groups. The high texture tightness and the low weight loss determined for the mixture of GMS and 150 mg/kg TE, and the colour indices (a*b*L*) have less significant change by adding the GMS with doses of 100 and 150 mg/kg of TE. Furthermore, the high antimicrobial activities resolution for GMS+TE150 mg/kg. In conclusion, the GMS+EO150 mg/kg coating could be used significantly for preserving the quality of oyster mushrooms throughout long-term storage.

1. Introduction

Today the production and consumption of edible mushrooms are increasing very fast throughout the world, mostly due to greater awareness of their nutritive and medicinal properties and their unique taste and texture (Jafri et al, 2013). Mushrooms are used not only as food but also as functional food and medicines due to high content of proteins and minerals, low cholesterol and starch, and also different bioactive compound (Sedaghat and Zahedi, 2012).

One of the most problems and challenges in the maintaining, post-harvest distribution, and retail of mushrooms is the short shelf life and highly perishable. This quick deterioration is mainly caused by high loss of water, metabolic activity, respiration rate, and dehydration (Fattahifar et al, 2018; Ares et al, 2006). Mushrooms, due to an inadequate cuticle layer on the cap surface are susceptible to shrivel and decay because the cuticle protects it from physical damage, water evaporation and microbial attack (Kim et al., 2006).

Transpiration losses of the edible mushrooms are the most major problem during the storage process because of their high moisture content (Gupta et al., 2016). About 90 % of mushroom's texture contains water, and their shelf life is between 3 - 5 days (Mohapatra et al., 2010). Though, they start deteriorating instantly within a day after harvest (Gupta et al., 2015). The polyphenol oxidase enzyme is the main cause of the colour changes of the mushroom (Mohapatra et al., 2010; Bonilla et al., 2012).

Due to the high unpreserved nature of mushrooms, several protective methods such as 1-MCP (Suna et al., 2020), pistachio green hull extract (Fattahifar, et al., 2018), modified atmosphere packaging (Jafri et al., 2013), edible coating (Sedaghat and Zahedi, 2012), washing with anti-microbial and anti-browning compound (Cliffe-Byrnes et al., 2008); drying (Villaescusa et al., 2003), packaging (Cliffe-Byrnes & O'Beirne, 2007), application of the polymeric films (Hardenburg, 1990), and moisture absorbers such as sorbitol, sodium chloride, propylene glycol and polyvinyl alcohol (Villaescusa & Gil, 2002), have been considered (Gupta et al., 2016). Recent years, the use of films and edible covers for the preservation and increase of durability of the food products and the struggle to replace the biodegradable materials in keeping food materials have been considered (Bonilla et al., 2012).

Medicinal plants play an excellent role not only as a traditional medicine but also in several sciences such as pharmaceuticals for the development of novel drugs and nutraceuticals (Xue et al., 2015; Jamshidi-Kia et al., 2018). The genus Thyme (Thymus vulgaris L), belongs to the Lamiaceae family and comprises more than 400 species plants with the medicinal and nonmedical uses, worldwide (Ozudogru et al., 2011). It has been used for many centuries in traditional medicine due to their amazing biological activities such as antiseptic, carminative, antiviral, antioxidant (Stahl-Biskup, 2002), anti-inflammatory, hepatoprotective, antimicrobial, anti-HIV-1, antiulcer, gastroprotective, hypoglycemic and antihyperlipidemic activities as well as particular cytotoxicity against a variety of tumour cell lines (Martins et al., 2015; Leal et al., 2017). This aromatic plant is geographically native to hot regions of Pakistan, Afghanistan, and south and southeast of Iran (Cristina et al., 2010). Due to the presence of secondary metabolites in the thymus plant, and their several biological activities according to previous studies, it is likely that the extract of this plant may have a protective effect on the survival of some quickly biodegradable foods. Therefore, the main objective of the present research was to assay the inhibitory effect of edible coating with combined Thymus vulgaris extract and glycerol monostearate on extending shelf life and of oyster mushroom.

2. Materials and methods

2.1. Materials

Mushrooms

The white Pleurotus mushrooms were harvested in the first flush, and they were white in colour, with a cap diameter of 3–4 cm. They were transported by refrigerator vehicle at 2–4 °C during one hour to the laboratory.

Chemicals

All solvents and chemicals such as glycerol monostearate (GSM), polysorbate 80, sodium sulfate, deionized water, peptone water, plate dextrose agar and plate count agar were analytical grade and purchased from Merck Company (Merck, Germany).

2.2. Sample preparation

The preparation of aqueous thyme extract was performed according to the Samadlooiy et al., (2007), by the Clevenger technique. Then, the extract was dried with sodium sulfate and kept at 4° C (Samadlooiy et al., 2007).

2.3. Preparation of mushroom treatments

The mushroom treatments were prepared properly with different concentrations of the GMS and TE, according to Ayobi et al., (2013) method (Table 1).

2.4. Gas chromatography-mass spectroscopy (GC-MS) analysis of the thyme extract

The thyme extract (TE) was subjected to the 7890B (Agilent Technologies, USA) Gas chromatography-Mass spectroscopy (GC-MS). Electron ionization (El) mass spectra (scan range, m/z 50-500) was obtained using electronic with an energy of 70 EV and filament emission of 0.5 Ma. The GC separations were conducted using an HP-5MS UI column (60 m × 0.025 mm i.d., film thickness 0.5 µm). Helium was used as

Table 1. Preparation of mushroom samples with different concentrations of thyme extract (TE), and glycerol monostearate (GMS).

Treatment	*TE (mg/kg)	**GMS (%)	***PS 80 (%)
1	-	0.5	0.5
2	100	0.5	0.5
3	150	0.5	0.5

*TE: thymus extract; **GMS: glycerol monoestearate;*** PS 80: polysorbate 80.

the carrier gas (flow: 0.8 ml min-1). The GC oven was temperature programmed at 5˚C min-1 from 60˚C after 3 min since the sample injection and held at 250˚C for 4 min. The injection port of the GC, transfer line, and ion source of 5977 MSD were respectively maintained at 240˚C, 250˚C, and 220˚C, respectively. The separated compounds were identified of standards and technology (NIST MS database, 2014) library. The relative per cent amount of each component was measured by comparing its average peak area to the total areas (Adams, 2007).

2.5. The texture tightness

A CNS Farnell texture analyzer (CNS Farnell, USA), was used to measure the texture tightness of the mushroom samples with different covering conditions. The permeability test was used to measure the sample texture. The diameter of the probe and permeability depth in the mushroom cap were respectively, 3 and 5 mm. Moreover, the permeability speed was 10 mm s-1. The extreme required force (N), to create the hole in depth of 5 mm was recorded as the tightness (Sedaghat and Zahedi, 2012).

2.6. Colour measurement

The HunterLab device (HunterLab Scan XE, Reston, VA) was used to evaluate the colour of samples. For this purpose, three parameters of "a*", "b*" and "L*" were measured in defining times according to Jiang et al., (2010).

2.7. Weight loss measurement

The sample weights were measured according to Poverenov et al., (2018), in days 0, 3, 6, 9, 12, and 15, using an analytical Sartorius digital balance (Sartorius, UK). The samples were kept at 4˚ C. The weight loss is reported as:

$$\text{weight loss (\%)} = \frac{W_a - W_b}{W_a} \times 100$$

Where, Wa: the initial weight (g); Wb: the final weight (g).

2.8. The microbial assay

A volume of 225 ml of sterile peptone water was added to 25 g of the mushroom sample. Total bacteria counts were determined by surface inoculation of plate count agar (PCA) (Merck, Germany), as well as the yeast and mould counts by surface inoculation of potato dextrose agar (PDA) (Merck, Germany). Then, the PCA plates were incubated at 32 °C for 48 h and PDA plates at 28 °C for a week. All samples at days 0, 3, 6, 9, 12 and 15 were separately prepared. (Poverenov et al., 2018).

2.9. Sensory evaluation

The hedonic test was carried out with trained students, including the 6 females and 4 males at the laboratory of Food Science and Technology at Yasooj University, Iran. The examination was performed in triplicate on several days. Five samples were served in a randomized order at each session, and panellists were given a break and neutralized with water between each session (Geier et al., 2016). They evaluated the appearance, texture and colour of different concentrations of GMS, using a nine-point scale, where, "1" indicate to very weak, "5" indicate to moderate, and "9" indicate to very well (Phat et al., 2018).

2.10. Statistical analysis

Measurements in all the experimental analyses were expressed as Mean ± SD (n = 3). The statistical software package IBM SPSS V.21 (SPSS Inc., Chicago, IL, USA) was used for the analysis. The results of

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the study were confirmed for statistical significance with Duncan's multiple range tests. Differences were considered statistically significant at the $p< 0.05$.

3. Results and discussions

3.1. GC–MS analysis of the thyme extract

Analysis of the extract using the GC-MS has detected the 23 chemical compounds with the noteworthy structures and diverse functional groups (C1-C23) (Table 2). The results illustrate that carvacrol (43.1 %), paracymin (19%) and thymol (14.8 %), were respectively the most abundant compounds occurred in the TE.

3.2. Texture tightness

The computer vision results of mushrooms coated at different concentrations are shown in Figure 1. The results illustrate that the texture tightness for all samples was decreased significantly during 15 days storage ($p<0.05$). The results indicated that with adding the GMS the weight loss happened from 36.1 ± 0.42 g to 15.7 ± 0.63 g, during the 15 days; while, adding the 100 mg/kg thymus plant extract to GMS, the percentage of degradation in mushroom texture was decreased from 36.1 ± 0.49 g to 19.6 ± 0.27 g. Adding the 150 mg/kg of the thymus plant extract had the most impact on preserving the texture mushrooms. In the study of Salehi et al., (2019), the sample which coated with GMS exhibited the losing weight from 36.2± 0.61 g to 22.1± 0.33 g. On the other hand, the control sample was decayed earlier than other samples during the storage time. According to Lin et al., (2019), the weight loss in mushroom samples may be due to the pectolytic and microbial enzyme activities that make the cell wall degradation, and consequently the moisture loss, with the passage of time.

The GMS covers the surface of mushroom cells with appropriate treatment regarding its lipid structure, so that it prevents microorganism growth and moisture loss in addition to delay spoilage and the activity of destructive enzymes effectively (Pantoja-Romero et al., 2016). In a similar study, Li et al., (2011), were used the zinc oxide nanoparticles to cover the apple pieces, and they found, use of anti-microbial compounds in coverage retained the texture, fresh and significantly increased the shelf life of apple samples.

3.3. Huntr Lab colour measurement

The effect of mushroom colour on decision-making has an evident feature in consumer manners, such as how the color impact on price perceptions, consumers' state of mind and purchase intents (Kim et al., 2018). Accordingly, a study of the colour indices of "a*", "b*" and "L*" was assessed entirely by the Huntrlab colour measurement device.

The colour index of "a*" shows Red vs. Green; where a positive number indicates the red and a negative number indicates the green colour. The overview of

Table 2. Chemical compositions (C1-C23) obtained from the GC-MS analysis of the thyme extract.

No.	Compound	Abundance (%)	RI	No.	Compound	Abundance (%)	RI
C1	Alpha-thujene	0.15	927	C 13	Terpin-4-ol	0.2	1186
C2	Alpha-pinene	3.14	932	C 14	Dihydrocarvone	0.3	1199
C3	Camphene	0.2	958	C 15	Carvacrol methyl ether	3.5	1228
C4	Beta-pinene	0.4	972	C 16	Thymol	14.8	1231
C5	Myrcene	2.3	994	C 17	Carvacrol	43.1	1302
C6	Alpha-phellandrene	0.25	999	C 18	Carvacrol acetate	3.1	1373
C7	Delta-3-carene	0.25	1011	C 19	Beta-caryophyllene	2.2	1418
C8	Alpha-terpiene	0.9	1113	C 20	Alpha-humulene	0.2	1449
C9	P-cymene	19	1119	C 21	Allo-aromadendrene	0.2	1460
C10	1,8-cineol	0.2	1031	C 22	Bicyclogermacrene	0.2	1500
C11	Gama-terpienne	3.1	1050	C 23	Caryophyllene oxide	0.3	1569
C12	Linalool	0.5	1082				

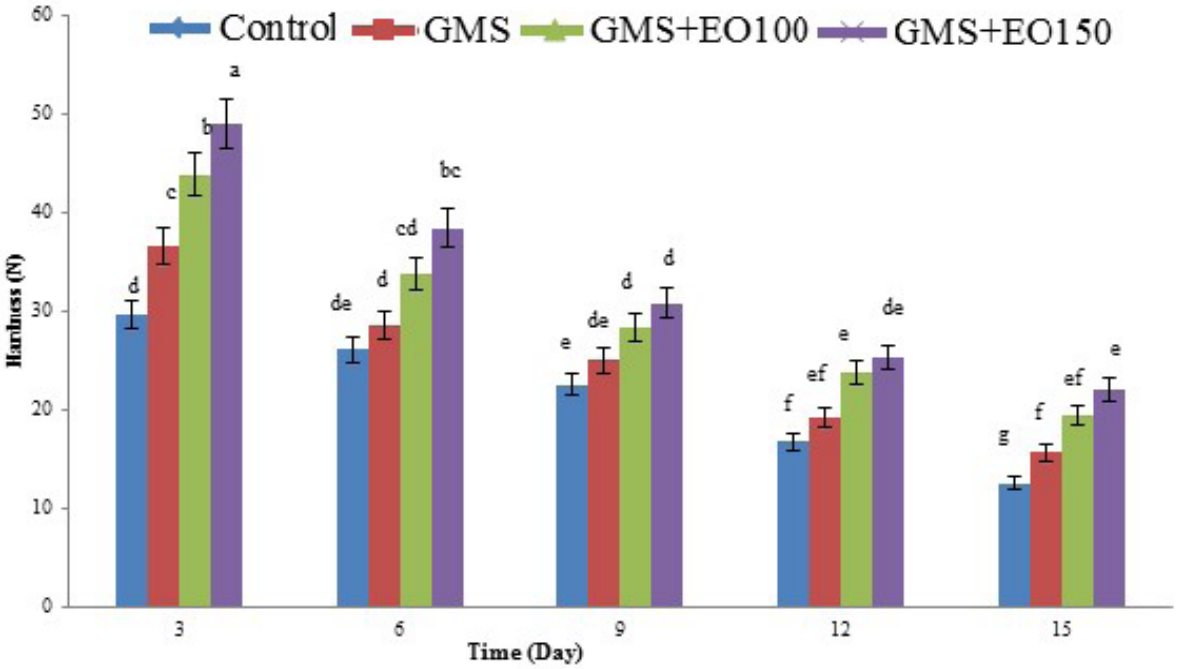

Figure 1. Effect of coating with glycerol monostearate (GMS) and thyme extract (TE) on the texture tightness of the mushroom samples * Non-identical letters in columns indicate the significant difference with the control group ($p < 0.05$).

"a*" colour index pointed out, there was increased during storage (Figure 2a), due to the physiological and microbial procedures (Cullere et al., 2018).

The use of GMS caused a slight change in the amount of "a*" colour index in comparison with the control groups. It was significantly increased from 2.71 ± 0.03 to 4.89 ± 0.08, during the 15 days ($p<0.05$). Correspondingly, there was a slight increasing amount of "a*" colour index by adding 100 mg/kg of the TE to the GMS from 2.80 ± 0.01 to 4.24 ± 0.04. That led to an increase in durability and stability of the "a*" colour index in mushroom samples as the minimum changes of "a*" colour index was correlated to the mushroom samples, which were coated by GMS. A concentration of 150 mg/kg, the thymus plant extract led to an insignificant increase from 2.82 ± 0.01 to 4.15 ± 0.03, during the 15-days storage time. Noticeably, the control group had potentially accelerated changes in the "a*" colour index during the maintenance period.

The "b*" colour index shows yellow vs. blue colour, where a positive number indicates yellow and a negative number indicates the blue colours.

As Figure 2b illustrates, the "b*" colour index has approximately similar results to index "a*", with increase durability and stability of colour of the mushroom samples during the 15-day storage time.

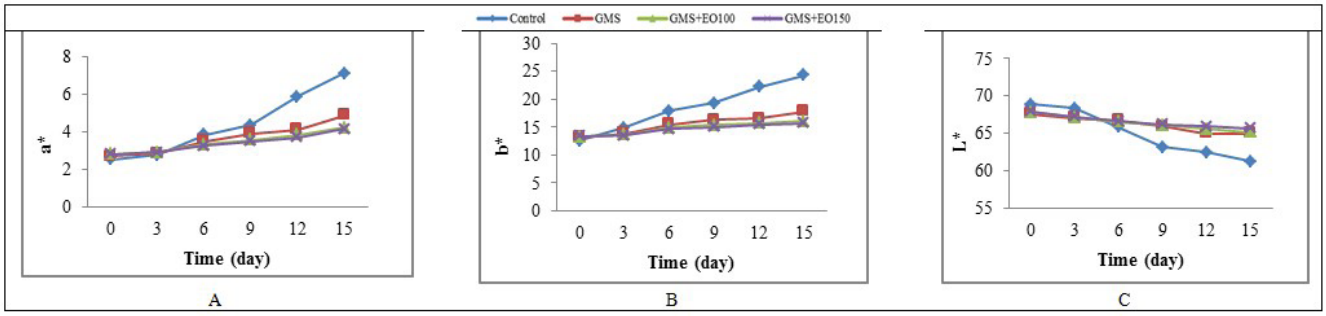

Figure 2. Effect of coating with glycerol monostearate (GMS) and thyme extract (TE) on "a*" (A), "b*" (B), and "L*" (C) indices of the mushroom samples.

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The GMS decreased significantly the "b*" colour index ($p<0.05$). Adding concentrations of 100 and 150 mg/kg of thymus plant extract to the glycerol monostearate (GMS+TE100 and GMS+TE150 mg/kg), led to an insignificant growing up in the "b*" colour index.

The "L*" colour index shows light vs. dark colour where a low number (0-50), indicates dark, and a high number (51-100), indicates brightness. The colour vividness of mushroom samples has a vital role to be purchased with an inclination of consumers (Sapers et al., 1994). Evidently, in the (Figure 2C), the amounts of "L*" colour index were decreased significantly in treated and non-treated samples during the 15 days ($p<0.05$). Furthermore, in the control groups (non-treated), the fewest changes in the brightness and transparency of mushroom samples are related to adding the 150 mg/kg of the thyme extract to GMS. The TE could constantly maintain the "L*" colour index and had been effective in preserving brightness and appearance of mushroom samples.

The TE could strengthen the positive function of the GMS, because of the phenolic compounds content of the plant, which has too many anti-microbial (El-Din et al., 2009), and anti-oxidant activities (Ziani et al., 2019). According to Taghizadeh et al., (2009), appraising the mushroom's shelf life through the imaging technique, it was shown the negative influences on all colour parameters during the storage period.

3.4. Changes in weight loss

The results of the firmness of coated and uncoated mushrooms demonstrated a clear favourable effect of GMS coating. Figure 3, represents the texture patterns of the coated and non-coated mushrooms during the 15 days of storage. The weight loss value increased over the total storage time in all samples. On day 12th, the GMS-coated mushrooms had a firmer texture than the uncoated ones. It is well proven that edible coatings physically developed significantly the

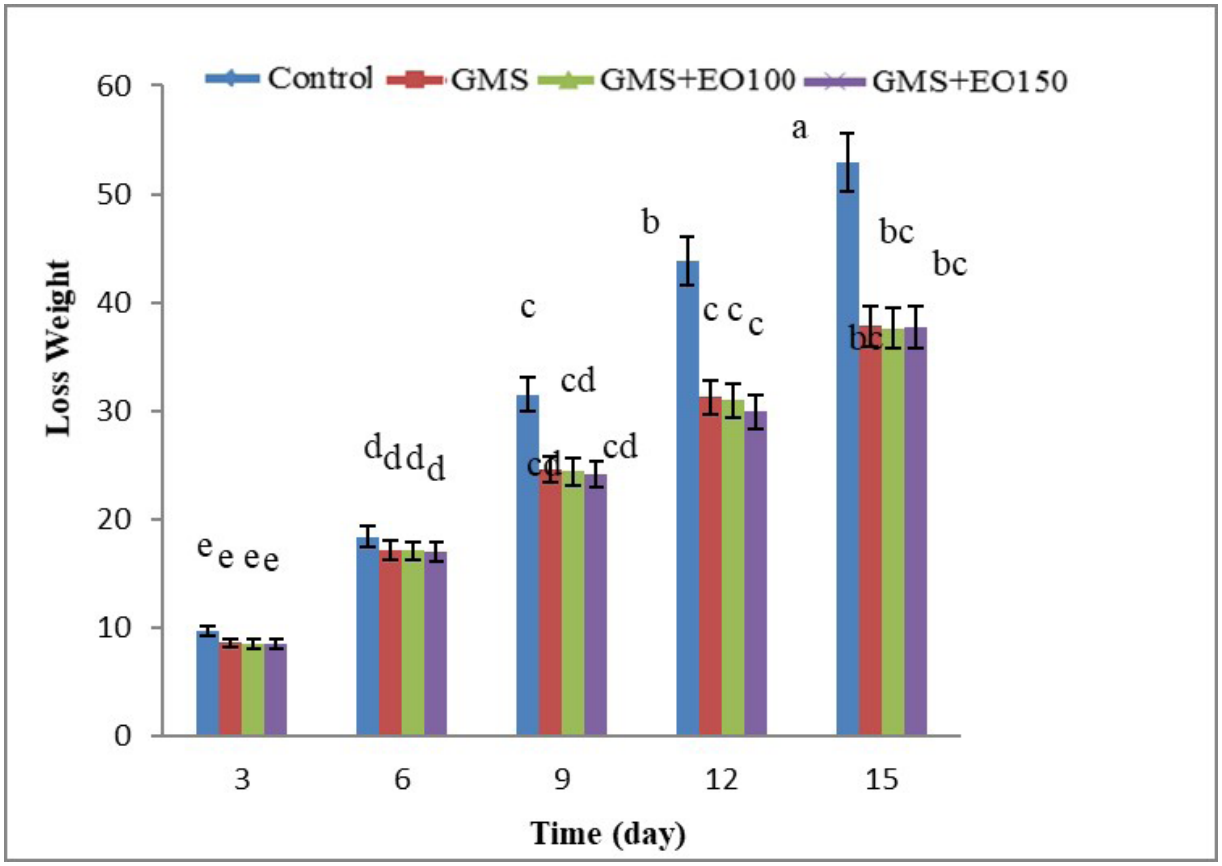

Figure 3. Effect of coating with glycerol monostearate (GMS) and thyme extract (TE), on weight loss of mushroom samples. * Non-identical letters in columns indicate the significant difference with the control group ($p < 0.05$).

structure of mushrooms and the texture's corruption was slower than the control sample (Poverenov et al., 2018). On the other hand, no effect of adding the TE to the GMS was detected on a delay of weight loss during the storage period. There is no significant difference in weight loss between GMS-coated mushroom and without thyme extract samples.

The most important cause of the inhibitory weight loss effect by GMS during the storage period maybe attributed to its compound lipid structure that leads to obstruction of mushroom surface holes, reduction of oxygen penetration on the surface and prevention of cell breathing (Talele et al., 2018). This decrease in weight loss is accordingly important, because of its effects on physiological, microbial activities, texture tightness and colour of mushroom samples.

Xu et al., (2015) show that the inevitable biological process after harvesting is breathing that accelerates the mushroom's shrinkage. During the storage period, the carbohydrate content in the product gradually decreases and causes deleterious changes in the product (Christensen et al., 2019). In keeping with the Jiang et al., (2011), the exposure of oxygen to the surface of the mushroom cells is one of the main reasons for weight losing. The packaging process is an effective factor in avoiding oxygen penetration and delay the mechanism of breathing (Perdones et al., 2012).

3.5. The sensory evaluation

The colour and form of edible mushrooms are very important for consumers. Therefore, this study appraised the sensory evaluation based on the colour and appearance. The results are shown in Figure 4. The quality of edible mushroom was decreased significantly in all of the test and control groups during 15 days of storage period ($p<0.05$). Presence of GMS has been significantly reduced the appearance and colour of mushroom samples, during the storage period ($p<0.05$), as well as the declining effectiveness of the TE on colour specification. The control and

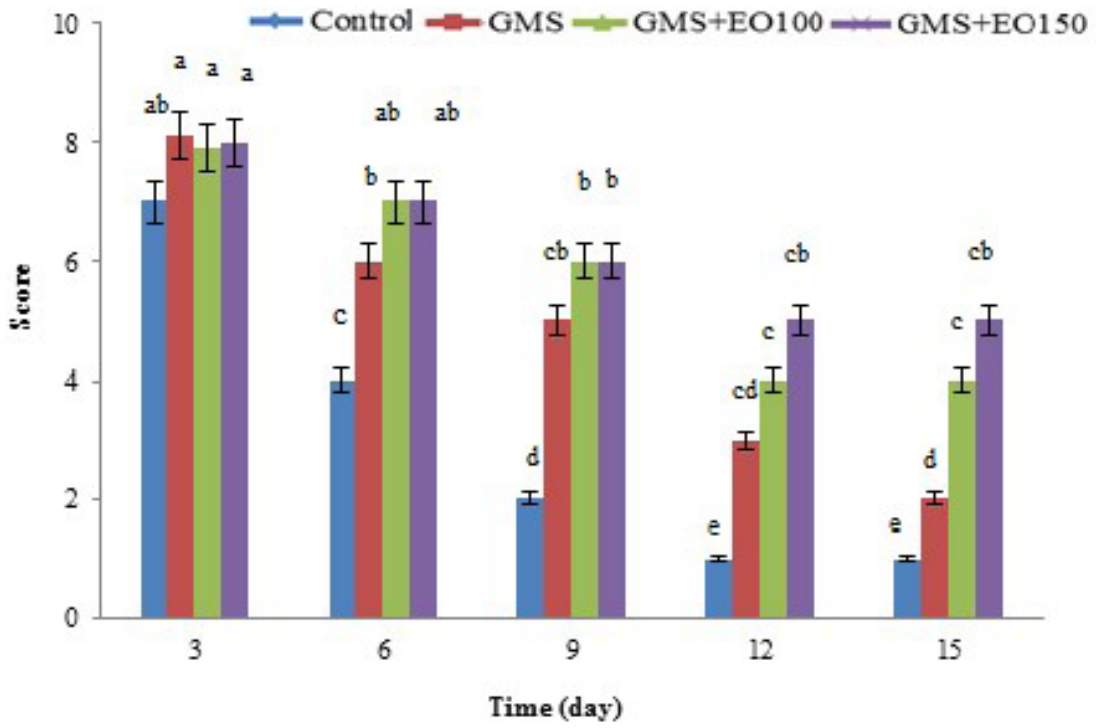

Figure 4. Sensory evaluations of the colour and appearance of mushroom samples covered with glycerol monostearate (GMS) and different concentrations (TE100, and TE150 mg/kg) of the thyme extract during storage time. * Non-identical letters in columns indicate the significant difference with the control group ($p < 0.05$).

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the GMS+TE150 mg/kg groups had respectively, the minimum and maximum scores for the appearance and colour factors. Overall, the colour stability in the samples in the presence of the extracts can be attributed to the decrease in some factors such as microorganism growth, physiological activities, weight loss and cell breathing.

3.6. Antimicrobial assay

The medicinal thyme extracts are used in numerous fields of the industries and sciences such as food industries (Elgayyar et al., 2001), pharmaceuticals, and traditional and modern medicine (Raskin et al., 2002). They are expected as novel resources of the antimicrobial agents (Bankole et al., 2007). Traditionally, the extracts and essential oils of the TE are used as medicinal plants in several areas of the world, including Iran for many purposes, particularly for microbial disorders. The thymus essential oil has an excellent effect against E. coli O157: H7 (Maksimović et al., 2008).

Because the overall growth of microorganisms is the main cause of deterioration in sensitive products such as edible mushrooms; hence, in the current study, this parameter was measured during the 15 days in different conditions of coverage. Concerning the data shown in Figure 5A, the overall growth of microorganisms was significantly occurred with increasing the storage period ($p < 0.05$). The results show that the use of GMS can significantly prevent the growth of microorganisms in comparison with the control group; especially, from the sixth day ($p<0.05$). Also, adding the thyme extract to GMS as a preservative compound could play an inhibitory role in the growth of microorganisms. In a dose-dependent manner, it could significantly prevent the growth of microorganisms ($p<0.05$).

In the current study, the effect of covering in different conditions using GMS and extract on the growth of mould and yeast was also evaluated. The results are shown in Figure 5B. The results indicate similar to studying the overall growth of microorganisms, by increasing the storage time, the amount of mould and yeast is increased significantly from the first day to the fifteenth day ($p<0.05$). The most increase was related to the control group and the least increase of the mould and yeast amount was related to the sample that was covered by GMS+TE150 mg/kg. The results of this research indicated that use of the GMS to cover the edible mushroom could have a significant influence on decrease the amount of mould and yeast in mushroom ($p<0.05$). On the other hand, use of the TE could intensify the effect of preventing mould and fungi growth of GMS compound. With increasing concentrations of GMS compound to 150 mg/kg, this influence was increased. It is proven that by covering the surface pores with GMS and therefore decrease the

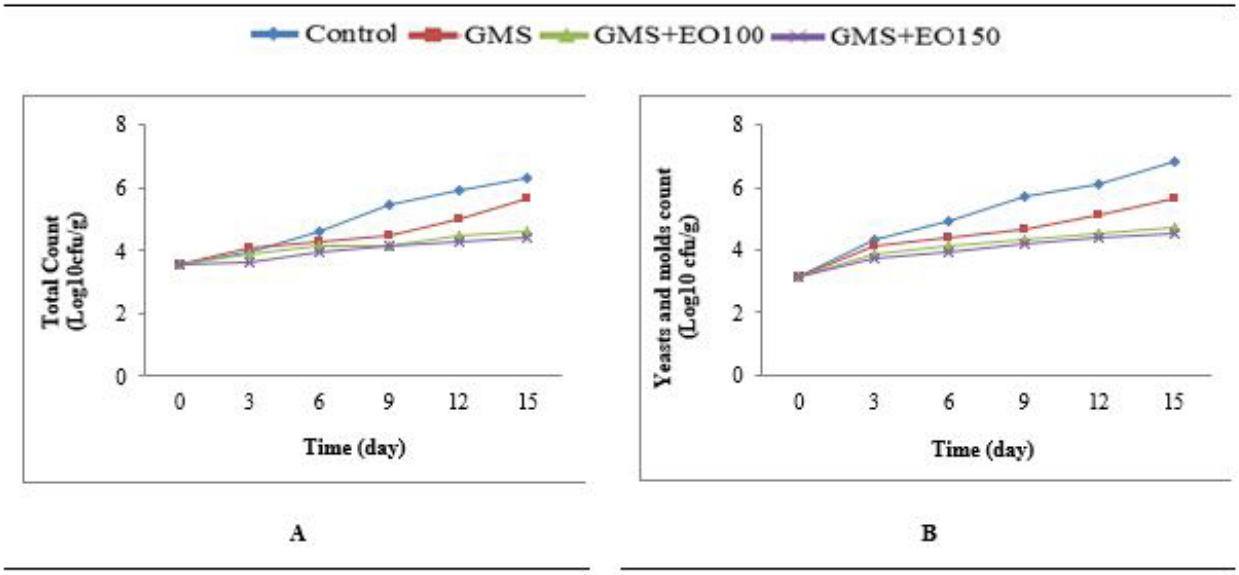

Figure 5. Effect of coating of mushroom with glycerol monostearate and thyme extract on total count (log10cfu/g) (A), and overall growth of moulds and yeast (B), during the storage period.

oxygen and available moisture prevents the excessive growth and reproduction of microorganisms. It was more effective than the control sample, which had no coating. On the other hand, this effect was dose-dependently increased with increasing concentrations of thymus extract.

In a comparable study, Jiang et al., (2011), showed that covering the mushrooms by chitosan can have a significant influence on decreasing the microorganism growth. These results were consistent with current studies. Similarly, in the study of Jiang et al., (2013), the coating of mushrooms with alginate and silver nanoparticles, had also significantly decreased the growth of microorganisms during the storage period.

4. Conclusion

In conclusion, the experiment conducted here indicated that the application of lipid-edible coating with different doses of glycerol monostearate (GMS) and thyme extract (TE) maintains the post-harvest mushroom´s quality. The high texture tightness and the low weight loss determined for the mixture of GMS and 150 mg/kg TE, and the colour indices (a*b*L*) have less significant change by adding the GMS with doses of 100 and 150 mg/kg of TE. Furthermore, the high antimicrobial activities resolute for GMS+TE150 mg/kg. In conclusion, the GMS+EO150 mg/kg coating could be applied to preserving the quality of oyster mushrooms throughout long-term storage.

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Conflict of Interest

The authors declare that there are no conflicts of interest.

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Comparative study on agrochemical residue on rice cultivation in Tasikmalaya, Indonesia: organic versus conventional

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Comparative study, organic rice, pesticide residue, tasikmalaya, indonesia

This study was designed to examine the agrochemical residue and farmer characteristic strategy in two methods of rice cultivation, organic and conventional. Two groups of farmers were examined, each group (n = 18) with five hectares of land for rice cultivation. This study conducted rapid rural appraisal (RRA) and focus group discussion (FGD), and determined agrochemical residue in water, soil and paddy. The results show that organic rice cultivation has a higher margin of profit at 0.32 USD/kg as compared to conventional rice cultivation, which is about 0.12 USD/kg. In organic rice cultivation, farmers have to spend more time in the cultivation process as opposed to the conventional forms of cultivation. This is mainly due to the time-consuming manure preparation process as well as plant protection. Agrochemical residues are detected only in conventional rice cultivation. Diazinon, Aldrin, Heptachlor, and Dieldrin were detected as the major chemicals present. Diazinon was detected in the water, soil and plants with a frequency of occurrence at 60%, 80% and 40%, respectively. Aldrin, Heptachlor and Dieldrin were detected in plants with the frequency of occurrence at 40%, 60% and 60%, respectively. Furthermore, heavy metals such as Mercury (Hg) and Arsenic (As) were also detected in the water with a frequency of occurrence at 10% and 40%.

1. Introduction

Rice is one of the most important food crops for over half of the world's population, especially in and around Asian countries, as a staple source of nutrition, providing carbohydrates, protein, fat, vitamin, and minerals. In modern agriculture, agrochemicals (both pesticides and synthetic fertilisers) play an important role in intensive agriculture. Indonesia is an agricultural country with approximately 8.087 million hectares of land area used for rice cultivation (BPS, 2018). Large amounts of agrochemicals are used to control pests, weeds, and diseases to protect the crops and increase agricultural production. In 2016, over 3.930 agrochemicals were registered in Indonesia (DSPKP, 2016). Pesticides of various kinds have been used on a large scale in Indonesia since the beginning of the green revolution between 1980–1990 (David & Ardiansyah, 2017a). Green revolution refers to the set of research and technology transfer in agriculture to increase agriculture production. They are used globally in the industrial agricultural system to control pest population; they protect crops from losses/yield reduction, improve the quality of rice and prolong

shelf-life (Abdollazadeh et al., 2015; Onojoh, 2013). According to Aktar et al. (2016), there are different types of pesticides including insecticides, fungicides, herbicides, rodenticides, molluscicides, and nematicides. The uses of chemical fertilisers have become an essential component of modern rice production technology to provide appropriate nutrients for higher rice productivity (Singh & Singh, 2017). Food Agricultural Organization (FAO) reported that the use of fertiliser, such as Nitrogen (67%), Phosphate (33%) and Potassium (22%) increased significantly from 2002 to 2014 worldwide (FAOstat, 2018).

Pesticides have played an essential role in improving public health through disease vector reduction and increased food production (World Bank, 2008). Despite its benefits, the use and disposal of pesticides have resulted in the undesirable release of these toxic chemicals directly into the environment. While beneficial in farming, it produces several negative effects such as environmental pollution and risks to human health owing to their agrochemical residue in rice. Recently, farmers have begun to shift towards organic farming; they have begun fertilising soils and protecting crops with organic and sustainable techniques to offer healthier food and ensure environmental sustainability. This condition is followed by a massive demand for organic rice of premium quality (Hazra et al., 2018).

Organic rice is the second most purchased organic product in Indonesia (David & Ardiansyah, 2017b). The increase of organic food product consumption is triggered by the consumers' awareness of healthy foods and their concern regarding environmental protection (David & Ardiansyah, 2017b). Many studies have reported health as the foremost reason behind the increase in consumers purchasing organic foods. Baudry et al. (2018) suggested that an organic food-based diet may help reduce dietary pesticide exposure for at least a few organo-chemicals, such as those belonging to the organophosphate and pyrethroid families. However, Benbrook and Baker (2014) stated that organic food is not entirely free of pesticide residue. Data shows that organic foods are more likely to have pesticide residues than conventional, though far less likely to have multiple residues of pesticides. Additionally, on average, the pesticide level in organic foods is significantly lower than in inorganic foods (Smith-Spangler et al., 2012).

Studies have also compared organic farming with conventional farming systems across different parts of the world in terms of soil nutrient contents, yields, economics, biodiversity, environmental impact, greenhouse gas emission, carbon sequestration, energy use, groundwater pollution and food quality (Jahanban & Davari, 2013). On the one hand, farmers are aware of the health concerns caused by pesticide use and feel concerned about plant diseases (Luck & Grimm, 2018). The consumption of pesticide-contaminated foods may pose potential health risks; therefore, the contamination of the environment and food by pesticide residues is a significant issue in many parts of the world (Rice et al., 2007; Li et al., 2008; Karunamoorthi et al., 2011; Mohanthy et al., 2013).

The understanding of farmers' perceptions about the risk of pesticides and the determinants of pesticide overuse are important aspects that can help to modify their behaviour towards reducing the usage of pesticides (Jallow et al., 2017). The determination of pesticide residue in food becomes the essential requirement for consumers, producers and authorities. Therefore, to address consumer expectation of lesser agrochemical residue in organic agriculture in Indonesia, this study compares organic and conventional rice cultivation in the context of agrochemical residue.

2. Materials and Methods

2.1.Study sites

The study was conducted in the Southeast part of Tasikmalaya Regency in the West Java Provinces. Tasikmalaya Regency is one of the most critical organic agricultural areas in Java. Recently, it has been reported as one of the regencies that exports organic rice to Europe. This study focuses on two groups of farmers; one group of organic farmers and the other group of conventional farmers. The first group is an organic farmers' group named 'Sriwantani', located in Kampung Cipalegor Kecamatan Sukehening, and the second group is a conventional farmers' group named 'Jati Karya' Kecamatan Jamanis. The distance between both groups is 7 km. Both areas are located approximately 500 m above sea level, and the rate of rainfall is about 2.000 mm/year. The daily temperature on average is 18^{0}C–25^{0}C. These areas were selected for this study because these regions have similar geographical, cultural and practical characteristics but with differ-

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ent modes of cultivation. Data were collected between June–July 2018.

2.2. Ampling procedure

This study has been divided into four steps: (1) Survey diagnostic by using Rapid Rural Appraisal (RRA), (2) Focus Group discussion with farmers, (3) Collecting sample (plant, soil and water), and (4) Agrochemical residue determination.

2.2.1. Rapid rural appraisal (RRA)

RRA aims to examine the extent of contamination in organic farmlands as well as conventional ones. It generates information such as dosage, area of usage, type of agrochemical used, frequency of usage, productivity and rice varieties cultivated.

2.2.2. Focus group discussion (FGD)

FGD aims to gather information from farmers regarding their strategy when using pesticides and other agrochemicals. Furthermore, FGD also attempts to confirm the information gathered from RRA.

2.2.3. Sampling of soil, water, plant

Based on the RRA and FGD, soil, water and plant samples were collected by using grid systems. The soil was collected at a depth of 0–20 cm. One soil sample consisted of five sub-samples, which were taken from a 100-meter radius. Each subsampling was mixed, of which only 0.5 kg was collected. Water samples were collected from the river and from the water that flows through channels. Each water sample consisted of five sub-samples, which were mixed, of which only 500 ml was collected. Plant samples were collected by cutting the leaves and stems of paddy stalks. Each sample consisted of five sub-samples, that were mixed and, only 100 gr were collected. Each sub-sample consisted of 20 gr. All the sub-samples were stored in a tube container that was subsequently placed in a 50 L cool box. For one day, the samples were transported by car to the laboratory.

2.3. Agrochemical residue analysis determination

2.3.1. Gas Chromatography Mass spectrometry analysis (GC MS)

The analysis of agrochemicals was performed using the GC method. This method of analysis was described by Cid et al. (2007). Two kinds of extraction were used: Solid Phase Extraction (SPE) and Liquid-Liquid Extract (Falaki, 2019). Each sample was injected in the split mode on a Thermo Finnigan GC equipped with a 63 Ni-μ electron capture detector (ECD). The GC analysis employed a DB-5 MS capillary column (30 m x 0.25 mm; with a film thickness of 0.25 μm). The GC column temperature was programmed from 150^0 C to 300^{0}C at 8^{0}C/min and held at 300^{0}C for 10 min. The injector and detector temperatures were 250^0 to 300^{0}C. The Helium carrier and Nitrogen making up the gas flow were set at 150^{0}C at 2 and 3 mL/min. All samples were analysed for 16 OCPs.

2.3.2. High-Performance Liquid Chromatography-UV detection (HPLC)

Agilent Technologies 1220 infinity high-performance liquid chromatography with a UV/visible detector was used for the identification and quantification of pesticides. The separation was performed on a reversed-phase C-18 column (Water). The samples were injected manually. The detector was connected to the computer for data processing. In this study, a reversed-phase semi-micro column was used for simultaneous determination, reducing the solvent volume and measurement time and obtaining high separation. These pesticides, capable of determination by HPLC, were mainly selected among other pesticides to set a regulated value in Japan. Recovery tests from samples were ultimately performed for 27 pesticides. These were divided into five groups because the retention times of some of the pesticides were very close. The working condition of HPLC was binary gradient; the mobile phase was acetonitrile: water (60:40), the flow rate was 0.3 mL min-1, the injection volume was 25 μL, and the wavelength of the UV/visible detector was fixed at 254 nm for the pesticides.

2.3.3. Heavy metal analysis

Hg and As levels in the soil and plants were analysed by a two-step process: dry-ash and acid digestion. First, samples (5 g) in a crucible were dry ash by removing moisture at 105°C for 6 h. After, the dried samples were placed in the furnace at 500~600 °C for another 12-14 h until they turned into a white ash mineral. For the second step of acid digestion, the ash samples were

dissolved in concentrated nitric acid or HNO3/H2O2 with appropriate dilution (the samples being diluted to 25 mL with deionised water). Heavy metals in the acid-resolved samples were determined by using an atomic absorption spectrophotometer.

2.4. Data analysis

Descriptive analysis and cross-tabulations were used to simplify and compare the quantitative data, observation and measurement. Data are presented as mean ± SEM.

3. Result and Discussion

3.1 Observation

In both organic and conventional rice cultivation, the crops are irrigated by water spring. Water is available throughout the year, and both groups use similar varieties of seed "Sintanur". Wet rice cultivation is the most common type of agriculture (crop) in both groups. Based on FGD, the farmers admitted that the use of agrochemicals was higher in the conventional groups. This condition is confirmed by the study conducted by Luck and Grimm (2018) in Tasikmalaya. They stated that nearly 97% of respondents used synthetic fertilisers during the last planting period in the year of 2017. They also reported that the use of organic manure and organic pesticides was lower than 9% within the total number of respondents.

Most of the farmers in both groups have been farming for 13–20 years. However, the organic farming group began only four years before the study. The average land ownership is only 0.18 hectares for organic farming and 0.21 hectares for regular farming. The ownership of organic agriculture is lower than the national average of land ownership (BPS, 2018), which reported that the average amount of land owned by Indonesian farmers is 0.20 Hectares. A challenge here was that 0.20 Hectares of land was, in most cases, owned by farmers only as sharecroppers, as shown in Table 1.

The average respondent in our study is male, married and 54 years old. The average household size is three hectares for organic farmers and 4–5 hectares for conventional farmers. Organic rice cultivation only needs, on average, 0.8 USD/ha cost for plant protection by using organic pesticides. This is considered lower than conventional cultivation, which is up to 16.17 USD/ha. The cost is only calculated from how much farmers need for pesticide usage (organically or synthetic pesticide). Even though the cost for plant protection for organic farmers was lower than conventional farmers, the working time for plant protection was three times higher than for conventional farmers.

The margin of profit is calculated from the price gap between unhulled rice with a final selling price. The organic farmers gain a higher margin of profit compared to the conventional farmer. According to Tashi and Wangchuk (2016), the case study of organic and conventional rice production in Buthan found that the benefit-cost ratio was significantly higher in conventional cultivation. Furthermore, Pattabaont and Shivakoti (2009) found that organic rice production increases labour costs. Organic farmers believed that they have to spend more time on plant protection compared to conventional farmers.

According to Luck and Grimm (2018), who researched Tasikmalaya, on an average, households retained around half of their harvest for their consumption and the other half was sold or handed over to their landlord, based on the sharecropping arrangement. This condition was also prevalent in the area of our study, where both organic and conventional farmers sold half of their harvest to middlemen and kept the other half for consumption.

3.2.Focus Group Discussion (FGD)

Based on FGD, eighteen farmers in each group voluntarily participated in FGD. The farmers admitted that they often have to discuss their strategies on managing pests and diseases prior to cultivation (Table 2). Almost 55.5% of conventional farmers possess knowledge of the detrimental impact of pesticides on the environment. However, they continue adapting to the use of synthetic fertilisers and pesticides. In contrast, most of the organic farmers understand the gravity of the adverse impact of synthetic pesticides on their environment.
In Table 2, both groups' strategies for plant protection, as explained by the farmers, has been provided. Organic farmers use spice and other organic pesticides that are self-prepared. Most of the organic farmers

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Table 1. Comparison of organic and conventional farmers

Characteristic	Organic (n=18)	Conventional (n=18)
Farmers Age (years old)	54.94 ± 9.997	54.64 ±8.85
Education	Elementary School (n=15) Junior High School (n=3) Senior High School (n=0)	Elementary School (n=16) Junior High School (n=1) Senior High School (n=1)
Land (m^2)	1868.13 ± 863.29	2162.35± 959.58
Average of HH (persons)	3	4.5
Farming (years)/Organic (years)	19.83 ± 13.62 / (3.55± 0.78)	13.82 ±7.86
Land ownership	Owner (n=10) sharecroppers (n=8)	Owner (n=8) sharecroppers (n-10)
Cost for plant protection (USD ha^{-1})	0.8 ± 0.43	16.17 ± 3.12
Time spending for plant protection (hr)	4±0.08	1±0.5
Cost for Manure/fertiliser (USD ha^{-1})	20.03	92.85
Yield (kg/ha)	4246.03±456.52	6100.05±30.01
Margin of profit (USD kg^{-1})	±0.32	±0.21
Selling price of unhulled rice (USD kg^{-1})	0.41±0.016	0.31±0.010
Final Selling price of rice (USD kg^{-1})	0.73±0.075	0.52±0.075

HH: Households

have the required knowledge about different organic pesticides. Conversely, conventional farmers use insecticides, fungicides and herbicides frequently. Pesticides were the most frequently used agrochemical.

Both groups were exposed to organic rice production; there is a program of the local government of Tasikmalaya to increase organic rice production. However, only a group of farmers called Sriwantani agreed to convert their land completely and change to organic methods. The reason for the farmers' conversion is mainly due to a belief that the soil dries with the use of synthetic pesticides as well as syntenic fertilisers. Organic experts supervised the conversion. Meanwhile, a group of farmers called Jati Karya argued that they do not have a strong enough reason to convert their land to accommodate organic cultivation. So far, this group believes no issues have arisen from the use of synthetic fertiliser, both cost or environmental concerns. The degree of the 'do not' awareness about pesticides is strongly affected and influenced by their pest management methods. The implementation of alternative methods of pest control as determined by the farmers is based on the knowledge of the pros (beneficial effects) and cons (harmful effects) of using pesticides. Several variables have influenced their pest control strategies and attitude regarding pesticide use. It is entirely subjective and may depend on their socio-economic characteristics, farm characteristics, personal beliefs, tradition, perceptions and preferences (Abdollahzadeh et al., 2015). Pesticides enter and pollute any component of the environment in several ways, including application, accidental spillage or through the unauthorised dumping of pesticide products right on their container (Akoto et al., 2016).

According to Shahnaj (2010), the more educated farmers are, the more aware they are of the pesticide residue problem. However, in this study, the level of education of farmers does not reflect their motiva-

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tion in converting from conventional to organic cultivation. Convincing farmers that their perceptions of crop-yield loss due to pest-related disease are over-estimated and helping them improve their knowledge of pest management and pesticide safety do not, thus, serve as adequate arguments. Based on FGD, the organic farmers admitted that they were willing to convert from conventional to organic cultivation owing to the desire to keep the spring free from pesticide contamination and wanting to get better prices in the sale of produce as well.

3.3.Agrochemical residue

3.3.1 Organophosphates

The most common types of synthetic pesticides used are chlorinated hydrocarbons, organic phosphorus pesticides, and carbamate pesticides (Sawyer et al., 2003). Among the organophosphate pesticides, Diazinon was found to be a frequently recurring pesticide with 60% of presence from the total sampling in the water sample, 80% in the soil sample, and 40% in the plant sample (Table 3, Table 4, and Table 5). However, the Indonesian pesticide residue standard SNI 7313: 2008 regulated that the amount of maximum residue is allowed to vary based on a particular chemical compound. The occurrence of Diazinon is high in the soil sample, which is 80%, followed by 60% in the water samples. The residue levels of Diazinon exceeded the Indonesia national standard in water and soil samples. Organophosphorus pesticides, such as Diazinon, are more resistant to microbial degradation (Akoto et al., 2016).

Table 2. Frequency and plant protection strategy by farmers

List of Strategy	Organic	Conventional
Type of organic pesticide	Lemongrass, Dioscorea hispida Dennst, Cosmos caudatus, Nicotiana spp., L, Annona squamosa L., Annona muricata L., Allium sativum L., Tinospora crispa (L.)	Insecticide (n=7) (Peritroid, Carbamate, organo Organophospate Fenil Phenylpyrazole) Fungicide (n= 2) Herbicide (n= 1)
Frequency of spraying (times/weeks)	Lemongrass (1-2) Depending on how often the occurrence of pest	Insecticide (1-3) Fungicide (1) Herbicide (1)
Planting duration (days)	45	45
Pesticide dosage (ml/tank)	No pesticides	Insecticide (15 ml/tank) Herbicide Fungicide
Knowledge of pesticide residue	Knowing the negative impact: n=18	Knowing the negative impact: n=10, Not Sure there is a negative impact n=8

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Table 3. Organophosphates in water sample organic vs conventional

No. of samples (n)	Chlorpyriphos (mg/l)		Diazinon (mg/l)		Profenofos (mg/l)		Parathion (mg/l)	
	Or	Co	Or	Co	Or	Co	Or	Co
1	ND	ND	ND	0.47	ND	ND	ND	ND
2	ND	ND	ND	ND	ND	ND	ND	ND
3	ND	ND	ND	0.18	ND	ND	ND	ND
4	ND	ND	ND	0.42	ND	ND	ND	ND
5	ND	ND	ND	ND	ND	ND	ND	ND
mean ±SD	ND	ND	ND	0.35±0.15	ND	ND	ND	ND
Freq= % n	0%	0%	0%	60%	0%	0%	0%	0%
SNI7313:2008 SNI7387:2007	0.5		0.1		n.r		n.r	

ND: Not Detected; n.r: not yet regulated
SNI 7313:2008 and SNI 7387:2007: Indonesian Standard Limitation of Contaminant

Table 4. Organophosphates in soil sample organic vs conventional

No. of samples	Chlorpyriphos (mg/kg)		Diazinon (mg/kg)		Profenofos (mg/kg)		Parathion (mg/kg)	
	Or	Co	Or	Co	Or	Co	Or	Co
1	ND	ND	ND	ND	ND	ND	ND	ND
2	ND	ND	ND	0.73	ND	ND	ND	ND
3	ND	ND	ND	0.51	ND	ND	ND	ND
4	ND	ND	ND	0.89	ND	ND	ND	ND
5	ND	ND	ND	0.80	ND	ND	ND	ND
mean ±SD	ND	ND	ND	0.73±0.16	ND	ND	ND	ND
Freq= % n	0%	0%	0%	80%	0%	0%	0%	0%
SNI7313:2008 SNI7387:2007	0.5		0.1		n.r		n.r	

ND: Not Detected; n.r: not yet regulated
SNI 7313:2008 and SNI 7387:2007: Indonesian Standard Limitation of Contaminant

Table 5. Organophosphates in plant sample organic vs conventional

No. of samples	Chlorpyriphos (mg/kg)		Diazinon (mg/kg)		Profenofos (mg/kg)		Parathion (mg/kg)	
	Or	Co	Or	Co	Or	Co	Or	Co
1	ND	ND	ND	0.0019	ND	ND	ND	ND
2	ND	ND	ND	ND	ND	ND	ND	ND
3	ND	ND	ND	ND	ND	ND	ND	ND
4	ND	ND	ND	ND	ND	ND	ND	ND
5	ND	ND	ND	0.0025	ND	ND	ND	ND
mean ±SD	ND	ND	ND	0.0022±0.00	ND	ND	ND	ND
Freq= % n	0%	0%	0%	40%	0%	0%	0%	0%
SNI7313:2008 SNI7387:2007	0.5		0.1		n.r		n.r	

ND: Not Detected; n.r: not yet regulated
SNI 7313:2008 and SNI 7387:2007: Indonesian Standard Limitation of Contaminant

3.3.2. Organochlorine

Among the organochlorine pesticides, Lindan, Aldrin, Heptachlor, Dieldrin, Endrin, DDT, Endo-Sulfan I and Corbofuran were not detected both in the organic and conventional water and soil samples (Table 6 and Table 7). Aldrin, Haptaclor and Dieldrin were detected in plant samples in conventional farming with a frequency of occurrence at 40%, 60%, 60%, respectively (Table 8). Pesticides may gain access to groundwater and surface water supplies through direct application or percolation and run-off from treated areas. Concentrations are typically higher in surface water than in groundwater (Sawyer et al., 2003). According to Mackay et al. (2006), the distribution of pesticides between the water and the sediments depends on the physical-chemical properties of the compounds such as the sediments of organic carbon position coefficients (log Koc). Studies have shown that pesticides with log Koc values > 5 are primarily transported in the environment and are bound to suspend sediments (Schafer et al., 2008). According to the Indonesian Standard of pesticide contamination, Aldrin, in the plant samples were lower than the Indonesia National Standard (SNI 7387, 2007) (SNI 7313, 2008). Meanwhile, the minimum residue of Heptaclor has not been regulated yet. Dieldrin was detected to be higher than the Indonesian Standard and had the most occurrences in the organochlorine sample. In general, the chlorinated pesticides are the most resistant to biological degradation and may persist for months or even years, following application (Sawyer et al., 2003).

Table 6 Organochlorine in water sample organic vs conventional

No. of samples	Lindan (mg/l		Aldrin (mg/l)		Heptachlor (mg/l)		Dieldrin (mg/l)		Endrin (mg/l)		DDT (mg/l)		EndoSulfan I (mg/l)		Carbofuran (mg/l)	
	Or	Co	Or	Co	Or	Co	Or	Co	Or	Co	Or	Co	Or	Co	Or	Co
1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
mean ±SD	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Freq= % n	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
SNI7313:2008 SNI7387:2007	0.01		0.02		n.r		0.02		n.r		0.01		0.01		0.01	

ND: Not Detected; n.r: not yet regulated
SNI 7313:2008 and SNI 7387:2007: Indonesian Standard Limitation of Contaminant

Table 7. Organochlorine in soil sample organic vs conventional

No. of samples	Lindan (mg/kg)		Aldrin (mg/kg)		Heptachlor (mg/kg)		Dieldrin (mg/kg)		Endrin (mg/kg)		DDT (mg/kg)		EndoSulfan I(mg/kg)		Carbofuran (mg/kg)	
	Or	Co	Or	Co	Or	Co	Or	Co	Or	Co	Or	Co	Or	Co	Or	Co
1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
mean ±SD	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Freq= % n	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
SNI7313:2008 SNI7387:2007	0.01		0.02		n.r		0.02		n.r		0.01		0.01		0.01	

ND: Not Detected; n.r not yet regulated
SNI 7313:2008 and SNI 7387:2007: Indonesian Standard Limitation of Contaminant

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Table 8. Organochlorine in plant sample organic (or) vs. conventional (co)

No. of samples	Lindan (mg/kg)		Aldrin (mg/kg)		Heptachlor (mg/kg)		Dieldrin (mg/kg)		Endrin (mg/kg)		DDT (mg/kg)		EndoSulfan I (mg/kg)		Carbofuran (mg/kg)	
	Or	Co	Or	Co	Or	Co	Or	Co	Or	Co	Or	Co	Or	Co	Or	Co
1	ND	ND	ND	ND	ND	ND	ND	0.15	ND	ND	ND	ND	ND	ND	ND	ND
2	ND	ND	ND	ND	ND	0.02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3	ND	ND	ND	0.0019	ND	0.01	ND	0.16	ND	ND	ND	ND	ND	ND	ND	ND
4	ND	ND	ND	ND	ND	0.03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
5	ND	ND	ND	0.001	ND	ND	ND	0.15	ND	ND	ND	ND	ND	ND	ND	ND
mean ±SD	ND	ND	ND	0.0019 ±0.00	ND	0.02 ±0.01	ND	0.153 ±0.05	ND	ND	ND	ND	ND	ND	ND	ND
Freq= % n	0%	0%	0%	40%	0%	60%	0%	60%	0%	0%	0%	0%	0%	0%	0%	0%
SNI7313:2008 SNI7387:2007	0.01		0.02		n.r		0.02		n.r		0.01		0.01		0.01	

ND: Not Detected; n.r: not yet regulated
SNI 7313:2008 and SNI 7387:2007: Indonesian Standard Limitation of Contaminant

3.3.3. Heavy metals

Heavy metals, such as As and Hg, were not detected in organic rice cultivation. However, in conventional rice cultivation, they were detected frequently, with an occurrence at 10 % and 40 % for Mercury and Arsenic (Table 9). The level of heavy metals found in the sample was lower than the Indonesian National Standard, which was 0.5 mg/l for Arsenic, and 0.2 mg/l for Mercury. In this study, conventional farming did not violate national regulations (SNI 7387, 2007).

There is a broad debate on the contribution of agrochemicals to crop production and the negative impact of their use on the environment and human health. Ardiwinata and Nursyamsi (2012) studied pesticide residue central in Java. They found organochlorine and organophosphate residue, as well as carbamate insecticides residue in the rice, soil and water. Based on the Pesticides Commission, there are 1082 pesticide formulations, that were legally distributed across Indonesia, with insecticides being the highest in number (Komisi Pestisida, 2005). Meanwhile, according to the Ministry of Agriculture (2016), for subsidised fertilisation, there were five types of fertilisers distributed: urea, SP36, NPK, ZA and organic fertilisers. The

Table 9. Heavy metal in water sample organic (or) vs conventional (co)

No of Sample	As (mg/l)		Hg (mg/l)	
	Or	Co	Or	Co
1	ND	ND	ND	0.009
2	ND	0.01	ND	ND
3	ND	ND	ND	ND
4	ND	0.01	ND	ND
5	ND	ND	ND	ND
mean ±SD	ND	0.01±0.00	ND	0.009±0.00
Freq= % n	0%	40%	0%	10%
SNI7313:2008 SNI7387:2007	0.5		0.2	

ND: Not Detected
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realisations of subsidised fertiliser distribution are increasing, except for urea. Numerous monitoring studies from Europe and Japan have provided evidence that paddy rice cultivation is responsible for surface and groundwater contamination, with pesticide concentrations exceeding 0.1 µg /L (Lamers et al., 2011).

4. Conclusions

Based on our findings, we conclude that the levels of education of farmer did not reflect their awareness on converting conventional rice cultivation to organic rice cultivation. The primary reason for their motivation to cultivating organic crops owes to their awareness about the selling price and use of spring water. Organic rice cultivation has lower agrochemical residue and has specific benefits concerning the lower cost for plant protection as well as better selling price, economically as well as ecologically. Even though agrochemical residues in conventional farming are higher than organic farming, in particular, the level of the residue is still lower than the Indonesian National Standard. Organic farmers spend more time preparing their manure and organic pesticides compared to conventional farmers. The occurrence of heavy metals Hg and As was high in conventional rice cultivation as compared to organic rice cultivation.

Conflict of Interest

The authors declare no conflict of interest. In addition, 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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Future of Food: Journal on Food, Agriculture and Society
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How will the COVID-19 pandemic impact food security and virtual water "trade"?

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How will the COVID-19 pandemic impact food security and virtual water "trade"? This is not an easy question as we must consider the multifaceted and complex nature of the aspects and variables at play. Aspects to consider are both the global food supply system and access to food. The global food system is based on food production, food processing, food transport and trade. Furthermore, elements which could be affected by the virus are the food retailing sector and the income of final consumers. It is also necessary to look at how the pandemic impacts people's access to food in rich and poor economies, in rural and urban settings. The question therefore is, how is the pandemic impacting all these different aspects? Current studies have connected how the current food-system plays a determinant role in the use of irrigation water worldwide (1). When food is traded, the consequent "trade" of water embedded in food – virtual water "trade"- happens in parallel (1). Thus, if any disruption or greater change is going to happen in the current food-trade and food patterns, a parallel change in global virtual water trade is likely to follow.

Scenarios could move from a new food-protectionism to a completely opposite outcome: an increase in current patterns of food trading. Assuming that land and availability of capital remain unchanged and unaffected by COVID-19, two other factors in agricultural production could instead play a major role: availability of labour and availability of energy for irrigation. Regarding food-trade, petrol for food-transportation will also play a relevant role in the final price of goods. If input factors such as labour or energy should decrease for major food-exporters, the availability of food in the international market will decrease. In parallel, if labour shortage shall hit importing countries, they might require more food stocks from the market to fully cover their national consumption needs. Should these two factors fail to be available in food-exporting regions, the entire food trade could change worldwide. Currently, Saudi Arabia and Russia have increased their oil production, the use of gasoline and other fuels is dropping, and oil prices are at their lowest level in a generation (2). A possible outcome from the drop in energy price in the agricultural sector could be an increase in large-scale irrigation. As a consequence, big agri-food companies could increase their share in the global market. In parallel, a decrease in the costs of energy and oil would probably lead to a decrease in transportation costs and result in an increase of world food trade; therefore, increasing virtual water trade. On the other hand, it is not possible to predict the future conditions of agricultural workers and farmers in a post-coronavirus future. This will depend on political sentiments of governments toward immigrant workers and agricultural workers' health rights and their overall conditions.

In conclusion, the impact of COVID-19 on available workers and their health is certainly a determinant

factor. The availability of energy at a low cost is another key factor (3). We believe that farmers worldwide and rural workers in the field should be protected and taken care of by national health systems now and for free. They are the most exposed to poor living conditions. Agricultural workers, especially the migrant workforce (4), usually live in congested slums or informal settlements (especially in developing countries) (3; 5), where social distancing is impossible to practice. To ensure food security for all, we should protect poorer communities now more than ever, including those who produce and harvest our precious food and those who are not able to access it.

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How did the COVID-19 crisis relate to meeting global climate targets for 2020?

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The current coronavirus outbreak 2019 (COVID-19) may be a double-edged sword in the fight against climate change. In fact, 2020 marks a key assessment of climate protection initiatives and progress made by individual countries, which are due to submit their updated Nationally Determined Contributions (NDCs) as agreed in the Paris Agreement (1).

Although pre coronavirus crisis global GHG emissions are expected to continue growing by 1,9% (2), recent CO_2 calculations in Europe are predicting a surprising scenario. For instance, the German climate target for 2020, which until February 2020, was considered unattainable, should now be met (3). Due to this year's mild, stormy, windy winter, and, above all the coronavirus crisis, the target of 40% CO_2 savings, compared to 1990, is within reach.

While COVID-19 is "first and foremost an issue of human health and safety", the change in people's behaviour to contain the virus is having "some subtle effects on the environment" (4). Some of the spreading virus tangible effects on the environment have been, among others (e.g. air pollution, wildlife etc.), the decreasing use of gasoline, electricity, as well as a drop on fuel production and consumption. If similar trends can be proven for the performance of the G20 countries only, 2020 could represent an epic cornerstone not only for climate negotiations but also for the future world economy.

Yet, the COVID-19 crisis may also have negative implications and impacts on the climate, as a rebound effect is expected once the pandemic is over (5). In the short-term, some are already affecting electric vehicles (EV) and the solar sectors, challenged by dips in oil/gasoline prices, the decreasing demand, and disruptions to both supply chains and manufacturing facilities (5). Besides, low commodity prices may drastically alter food supply chains, resulting in increased levels of food loss and waste, as well as exacerbating existing scenarios of food insecurity, especially in developing countries (5)(6).

Notwithstanding the future developments, the current global situation is an opportunity to consider structural changes that may go hand-in-hand with the economic and environmental reforms needed to achieve a sound paradigm shift to avoid destabilizing the climate in order to have the best possible chance to avoid setting off irreversible chain reactions (e.g. melting glaciers etc.). This shift can and needs to be taken now (7)(8). While rethinking unforeseen and unexpected scenarios when drafting global climate targets, policy-makers and global leaders should envision a new world economy without fossil fuels, with a higher reliance on renewable energies, decreasing travels, shortening value chains, and challenging first-world living standards (9)(10). This pandemic is showing us that refinements are possible. Investments and measures taken beyond and after the coronavirus

crisis are what would define the global fight against climate change.

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The European Green Deal, Our Roadmap For a More Sustainable Economy

Photo credit: https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

The Farm to Fork Strategy

Although COVID-19 was a tough lesson to our mankind, it highlighted the importance of having a strong food system that is able to serve societies and ensure access to affordable food to all citizens equally. It is now more evident that it is not only important to keep ourselves healthy, but rather more important to maintain our planet healthy too. This pandemic is only one of the numerous risks that are threatening our food systems like floods, forest fires, and the appearance of new pests.

The European Green Deal is a set of policies presented by the European Commission that aims to make Europe climate neutral by 2050. It is considered the roadmap that promotes new strategies for a more sustainable economy that improves all societies' wellbeing in an equal and adequate manner. The Farm to Fork Strategy is the core of the European Green Deal that aims to make food systems fair, healthy, and environmentally-friendly. It recognizes the prominent link between the health of people, societies, and the planet. Besides, it addresses the challenges that are facing the current sustainable food systems. Moreover, The Farm to Fork Strategy works consistently with the Commission's agenda to achieve the United Nations' Sustainable Development Goals (SDGs).

Achieving a sustainable food system is getting more and more required globally as it not only brings environmental, health, and social benefits but also ensures faster recovery after a crisis like COVID-19.

Source: European Commission. Communication from the commission to the European parliament, the council, the European economic and social committee, and the committee of the regions. A Farm to Fork Strategy, for a fair, healthy, and environmentally-friendly food system. COM (2020) 381 final, Brussels (2020).

Retrieved from:

https://ec.europa.eu/food/farm2fork_en

file:///C:/Users/diana/Documents/FOFJournal/News/22.05%2020202%20communication-annex-farm-fork-green-deal_en.pdf

Global Forum for Food and Agriculture

Communiqué 2020

Photo credit: https://www.gffa-berlin.de

Food for All! Trade for Secure, Diverse, and Sustainable Nutrition.

Currently, more than 820 million people are suffering from hunger, while 2.5 billion are suffering from micronutrient deficiency. Urgent actions must be taken to advance food security and eliminates the root causes of these issues.

The agriculture ministers of 72 nations had a meeting on 18 January 2020 for the 12th Berlin Agriculture Ministers' Conference on the Global Forum for Food and Agriculture (GFFA). They discussed how to ensure food security for the world's increasing populations and boost sustainable food systems in order to improve farmers' lives and human health.

The meeting addressed four main challenges: Fostering trade for global food security, making trade work for agricultural development, making food value chains inclusive, sustainable, and safe, and strengthening fair rules in agricultural trade.

The members stressed that World Trade Organization (WTO) has an important role in achieving the 2030 Agenda for Sustainable Development, including its Sustainable Development Goals, especially Goal 2 "End hunger, achieve food security and improved nutrition and promote sustainable agriculture."

Source: Federal Ministry of Food and Agriculture. Global Forum for Food and Agriculture Communiqué 2020 Food for All! Trade for Secure, Diverse and Sustainable Nutrition. Berlin (2020)

Retrieved from: https://www.gffa-berlin.de/en/

https://www.gffa-berlin.de/wp-content/uploads/2020/02/GFFA-Communique-2020-EN.pdf

ISSN-Internet 2197-411x OLCL 862804632
UniKassel & VDW, Germany- August 2020

Are bees influenced by Covid 19 ?

YES, they are. Not so much wild bees, but in some countries on earth bees are "industrialized" used these days for pollination of e.g. fruit trees. This pollination they provide is a vital link in agriculture and food security. Therefore Apimondia- the International Federation of Beekeepers´Associations - wrote a Memorandum to all "Local, State and National Authorities - Allowing movement of beekeepers and bees during Covid-19 quarantines" (March 31st,2020). With this Memorandum they inform, that the French Department of Agriculture (Instruction technique DGAL/SDSPA/2020-199 20/03/2020) has put forth a formal statement on the needs and responsibilities of beekeepers in France and they would like to see similar reactions and formal statements in other countries of the world as well.

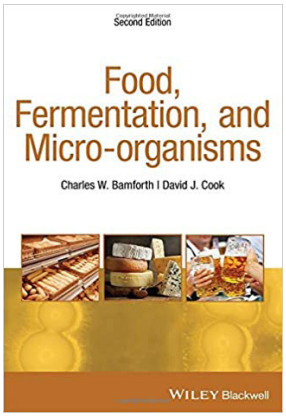
Here the English translation of official French text

"Overview: The beekeeper's intervention is essential to maintain the beekeeping stock, the perpetuity of the business and the maintenance of pollination services. Some beekeeping activities are dependent on the season and cannot be delayed over time without threatening the colonies, their health and harvests (regular visits to apiaries including health visits, swarming management, monitoring of requeening, transhumance, harvesting of hive products, breeding of bees/constitution of bee colonies, feeding in case of famine ...). These constraints concern all beekeepers, both part-time and professional. The possibility of supplying beekeeping supplies, materials and inputs (ex: wax) is also necessary for the proper implementation of these activities. Beekeeping work is often solitary. Certain work can be carried out in a small team, in particular in the biggest beekeeping concerns. Migratory beekeeping is traditionally implemented in certain regions by beekeepers to produce special interest honey and provide pollination service and / or to alleviate famines. Migrations are sometimes carried out over great distances (several hundred kilometres). Beekeeping activities are prioritized according to the methods defined below. Beekeeping activities to be postponed:-Visits within the framework of animal health programs -Visits provided by a third party not strictly necessary for the pursuit of beekeeping activity or maintaining the good health of the colonies,-Welcome groups, -Training actions (zootechnical, health, economic, apiary management, ...),-Physical meetingsBeekeeping activities authorized in strict compliance with the measures to prevent the spread of the virus (in particular the implementation of social separation and hygiene measures) and avoiding any grouping of people: -The visit of apiaries by the beekeeper and / or his staff by limiting the number of visits to what is strictly necessary, -Transhumance and hive movements, in compliance with the regulatory provisions provided for in article 13 of the ministerial decree of 11 August 1980 relating to the health system for combating bee diseases.

Note: Migratory beekeeping outside the national territory are subject to restrictions imposed by the Member State of destination.-Preparation of equipment for depot/warehouse (preparation of wax frames, cleaning equipment, ...), -Harvesting of beehive products, in particular extraction in honey production (adoption of strict hygiene and social distancing measures, in particular in collective honey production),-Honey packaging operations, -The breeding of queens / the constitution of swarms,-Unavoidable visits carried out by a veterinarian and/ or a beekeeping health technician (ASD) following a health problem observed in an apiary,-The sale and purchase of beekeeping equipment,-The sale of beehive products,-Required Sanitary action –carried out by a reduced team. To carry out these activities, people who have to travel must have the relevant certificate referred to by decree n ° 2020-260 of March 16, 2020."

Le directeur general adjoint
C.V.O
Loic EVAIN

International Federation of Beekeepers' Associations promotes scientific, ecological, social and economic apicultural development in all countries and the cooperation of beekeepers` associations, scientific bodies and of individuals involved in apiculture worldwide.



Food, Fermentations and Micro-Organism

A review by Varsha. V. Prabhu.

Authors: Charles W. Bamforth and David J. Cook
Publisher: Wiley Blackwell
Published year: 2019
Language: English
ISBN: 978-1-119-55743-2
Length: 264 pages

In their book, Charles W. Bamforth and David J. Cook discuss the role of microorganisms and their effect on foods during fermentation. The topics presented in this book would be of interest to those curious about the relationship between microorganisms and foods. Throughout its 17 chapters, the book focuses on topics that inform the reader about fermentation technology and the role of microorganisms in various food products such as beer, bread, cocoa, sake etc. Additionally, the book educates the reader about the processing of these foods and how microorganisms mainly help in food preservation but also cause food spoilage.

The book describes different microorganisms' cellular composition, morphology, reproduction etc. The first chapter provides a general overview on the varieties of microorganisms used in foods, as well as the temperature and the pH requirements for the survival of the microorganism and the methods to control its growth, such as heating, cooling and drying etc. Subsequently, the book pins down the role of microorganisms for one of the most popular fermented beverages: beer. The authors provide exhaustive information on beer processing, starting from barley and malt production to the packaging and spoilage of beer. This section unlocks the chemistry behind the fermentation process brought by the yeast saccharomyces spp. in beer, along with a detailed explanation of each step of the beer manufacturing process and key points for producing good quality beer. The authors also describe the flavour components (taste, aroma and texture) produced during beer manufacturing. This section discusses the volatile and non-volatile constituents (inorganic salts, sugars, amino acids and nucleotides) in beer which are responsible for the taste, aroma and texture. This chapter ends with the microorganism responsible for the spoilage of beer.

Alcoholic beverages can be divided into two main categories: distilled and undistilled. Undistilled beverages are also called fermented beverages (e.g. wine and beer). Whereas distilled beverages are alcohol concentrated beverages obtained after the removal of water and other components from the fermented substance. Examples include whisky, rum, cognac, vodka, etc. The book discusses each in separate chapters. The interpretation of these beverages is not as detailed as the production of beer in terms of processing, fermentation and packaging. However, the book does cover the important parameters required to understand the role of microorganisms in the fermentation process for each of these beverages. At the end of the chapter "Vodka, flavoured spirits and liqueurs" the book defines other types of alcoholic beverages per European Union definition in a tabular format. It provides details particular to that beverage such as the ingredient used, alcoholic strength required before selling and the microorganism used.

Fermentation is one of the oldest techniques used to preserve foods apart from its use to change the flavour of food. In addition to alcoholic beverages, fermentation is used in foods like bread, yoghurt, cheese, meat, cocoa and other vegetables for pickling. The book explores the types of microorganisms essential for these products along with a short description of the production methods. The readers can learn about the temperature, pH and the environmental conditions required by the microorganisms in these foods. The reader can also find a short description of the ingredients used for preparing these products and their impact on the final product. The information provided on these products is limited, but enough to grasp the concept and the idea of the entire process.

Additionally, the book pays attention to a small group of

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indigenous fermented products, mainly Soya sauce, Natto and Miso. The readers can acquire the details regarding the manufacturing process and the micro-organisms used.

Overall, the book delves into multiple fermented food products and provides pertinent information about each product. The book uses simple and clear language. However, the reader must have a fundamental knowledge of food chemistry and food microbiology. The reader can acquire several interesting facts and information in every chapter. Not all chapters are extensively detailed, however, the reader can refer to the bibliography for more information. All in all, the book is a good read to attain substantive knowledge on the fermentation process of different food products at an industrial level.

Information about the author:

Varsha. V. Prabhu. She is a student pursuing her Master of Science in International Food Business and Consumer Studies at Kassel University. She is a food technologist by profession and is always curious about recent trends in food product development.

CALL FOR PAPERS

Vol. 9, Number 1 2021

THE FUTURE OF FOOD JOURNAL
JOURNAL ON FOOD, AGRICULTURE & SOCIETY

Special Issue on Sustainable Agriculture & Food Systems

Current environmental challenges, global warming, climate change and the loss of biodiversity and natural resources are in one way or another linked to human behaviour. Unsustainable production methods and individual consumption could explain most of these challenges. These global issues are encouraging people to adopt better pro-environmental practices. Sustainable agriculture and sustainable food systems are helping meet society's current food needs, as well as textile and energy needs, without compromising the needs of future generations. However, there is still a worldwide debate about the relationship between agriculture and nature conservation. For example, how much arable land should be used for commodities linked to textile (such as cotton) or energy production (e.g. maize)? Still, sustainable agriculture is key to fostering food safety and sovereignty. Therefore, researchers and practitioners are required to strive and integrate the concepts, benefits and consequences of more sustainable agriculture and food systems in their work-related efforts.

Future of Food Journal is currently running a special issue entitled "Sustainable Agriculture & Food Systems". This special issue aims to highlight original research articles, researcher's opinions, news and book reviews on the related topic.

The topics include but are not limited to:

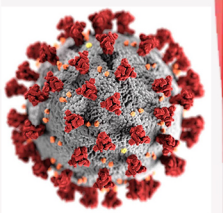
- Sustainable agricultural practices in different countries
- Economic, social and political context of value chains
- Food production and transformation e.g. urban agriculture
- Food consumption and Food education programs
- Farming and natural resources (e.g. biodiversity, climatic relevant emissions, water)
- Emerging trends and new technologies in sustainable agriculture and food systems

FOFJ is a free-of-charge, peer-reviewed and open-access online journal for international scholars and researchers supported by the University of Kassel and the Federation of German Scientists (VDW).

For further details on the submission process, please see the instructions for authors at the journal website:

http://www.thefutureoffoodjournal.com/index.php/FOFJ/information/authors

Special Call for Papers



THE FUTURE OF FOOD JOURNAL
JOURNAL ON FOOD, AGRICULTURE & SOCIETY

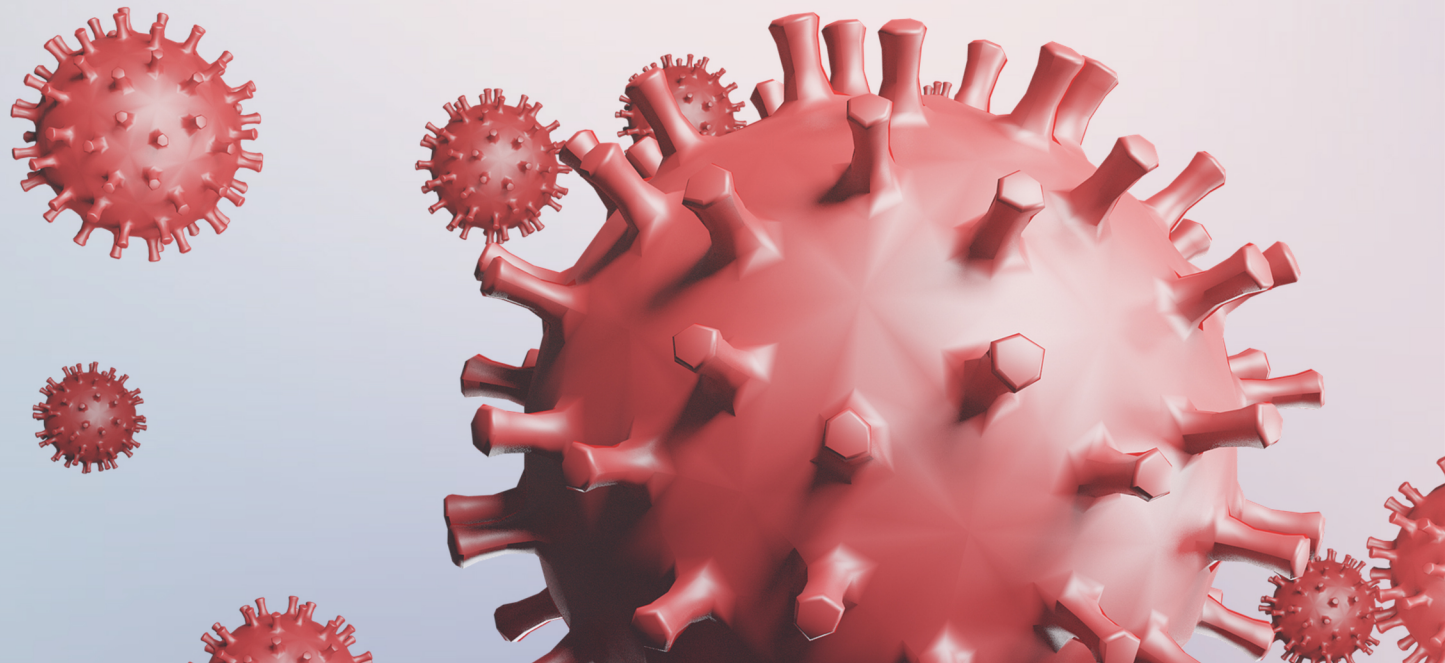
The multidimensional impacts of COVID 19 on the food systems

COVID 19 has been having multidimensional impacts on the food system, influencing food production, food trade, transport, and consumption. It also impacted water, energy, and labour supply, all directly linked to the food system. Nevertheless, the academic literature so far has been focusing on the measures adopted by governments during the pandemic, focusing on short term measures and solutions.
What is missing is a discussion on how COVID 19 is impacting the different dimensions of the food system both in the short term as well as in the long term.

This Special Issue call aims at developing such discussion, inviting scholars from different disciplines to engage in such an academic debate able to unpack and unfold the nuances behind impacts, responses, and implications. This would allow practitioners, policy makers, and scientists is to gain a better understanding of the problem at hand for the food system, on potential measures and solutions that could be adopted, and on their implications.

Furthermore, the special issue is also interested in understanding the how the pandemic is impacting the society and the people, including food producers and the most marginalised segments of societies, reflecting on how are peoples experiencing COVID-19 and what will be its long-term impact politically, economically, socially, and culturally? It encourages papers from a wide range of disciplines and methodological approaches.

Submission Guidelines - Deadline: December 31, 2020



Call for Reviewers

THE FUTURE OF FOOD JOURNAL
JOURNAL ON FOOD, AGRICULTURE & SOCIETY

Future of Food Journal is opining now a Call for Reviewers. Join us in our effort to reduce the manuscript processing lead time!

As the peer-review process is a fundamental criterion in scientific publication, the number of qualified reviewers is declining when the number of submissions is increasing. We are looking to expand our team of expert peer reviewers in the fields of:

1- Sustainable Agriculture
2- Sustainable Food system
3- Food Production & Technology
4- Nutrition and Diets
5- Environmental and Climate Sciences
6- Consumers Behaviour

And we would be delighted for you to join our team.

What to expect being a reviewer at FOFJ:

1- A great scientific experience
2- An acknowledgement in one of our published issues after the completion of 5 reviews
3- The opportunity to join the Editorial Board when a call for members is open
4- 100 € after the completion of 5 reviews

Your duties would be to:

1- Review the assigned paper within max. 3 weeks
2- Review the manuscript once it has been accepted and revised within max. 1 week

Looking forward to receiving your application.

Please follow the link below for the new online registration process:

https://www.thefutureoffoodjournal.com/index.php/FOFJ/user/callReviewer

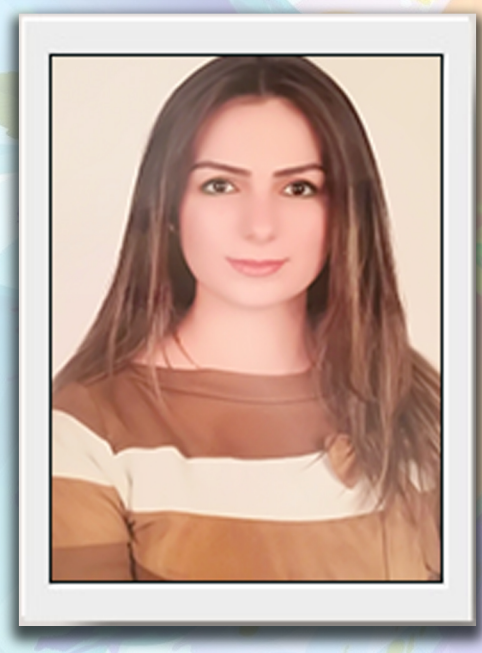
Editorial Announcement

THE FUTURE OF FOOD JOURNAL
JOURNAL ON FOOD, AGRICULTURE & SOCIETY

Introducing our new Editorial Board members

This year was a year of enormous challenges in various respects, but with excellent teamwork and management, the editors, reviewers, Editorial Board members, and of course, readers were and will continue to overcome all obstacles and work hard to provide the best.

On behalf of the Editorial Office, authors, and readers of FOFJ, we would like to welcome our new Editorial Board members who have invested significant efforts to advance the profile of FOFJ. We are looking forward to working with the newest members and reviewers, and we hope to live up to our authors and readers expectations.



Dr. Diana Hmaidosh

Dr. Diana Hmaidosh is a researcher with a strong knowledge of medicinal and aromatic plants and bio accumulators. She gained extensive experience in medical drug laboratory during her work in the laboratories of the Faculty of Pharmacy in both Tishreen university and Andalus Private Medical University, Syria.

She is an academic teacher and supervisor and has supervised several undergraduates, graduate and postgraduate students in the Faculty of Agriculture and Pharmacy at Tishreen University, Syria.
Currently, she works in the Department of Biodiversity- Cedar & Fir reserve, Ministry of Agriculture, Syria. Before that, she worked as a member of the National Environmental Observatory Project in the Ministry of Local Administration and Environment, where she obtained ten years of rich practical experience in GIS.

Dr. Hmaidosh obtained her Ph.D. degree from Tishreen University. During her studies, she conducted chemical experiments at the laboratories of the Agricultural faculty of Basra University, Iraq.
Her work and results were presented in many national and international scientific conferences. Before her Ph.D. studies, she obtained a BA and MA in Ecological science from Tishreen University, Syria.
Throughout her academic years, Dr. Hmaidosh has published several scientific papers.

Editorial Announcement

THE FUTURE OF FOOD JOURNAL
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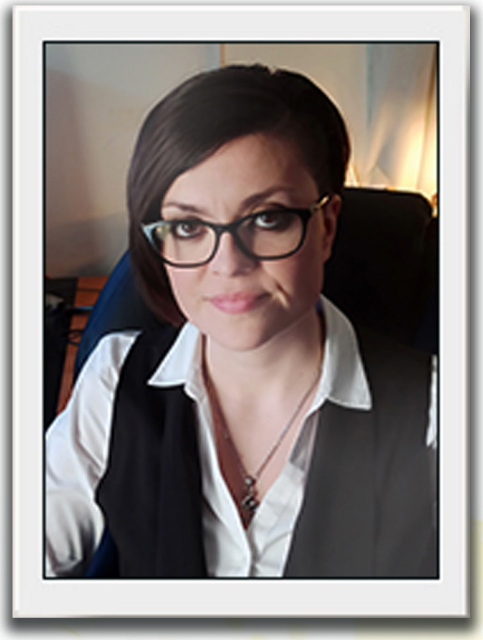

Dr. Morena Galesic

Morena Galesic is a researcher in water resources management and water pollution risk assessment at the University of Split, Croatia.
She has a background in civil engineering, including bachelor, master, and doctoral degrees, with an inclination to water resources and sustainability. During her research, she has been actively working on pollution transport problems by engaging analytical and numerical modelling, field measurements in river estuaries, and stakeholder workshops.
She is currently working on two major projects (STIM-REI, a project at the Center of Excellence for Science and Technology Integration of Mediterranean Region (STIM), connects research (R), innovation (I) and education (E), and Development of technology for assessment of autopurification capabilities of coastal waters - Coastal Autopurification Assessment Technology (CAAT)) focused on coastal waters, corresponding environment, and sustainability under growing pressure from climate change. As a part of a diverse team in charge of the Development strategy of the city of Split until 2030, she is coordinating and working in the fields of waste management and management of natural risks and climate change.

Morena is active at teaching in related subjects (water resources management, coastal engineering); she was also a participant at the UNLEASH Innovation lab organized by United Nations in June 2018 in Singapore, and worked as a facilitator at Mini-Unleash lab in December 2018 for University of Kassel.

She has multiple publications which may be found at:
https://scholar.google.com/citations?user=NrTo8VwAAAAJ&hl=en
https://www.researchgate.net/profile/Morena_Galesic

For the last 2 years, Morena has been an active reviewer for Environmental Science and Pollution Research (Springer), Water and Sustainability by MDPI (Multidisciplinary Digital Publishing Institute), where she is also a member of reviewer board:
https://www.mdpi.com/journal/water/submission_reviewers

Editorial Announcement

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Prof. Nasser Haboub

Nasser HABOUB is a university professor and researcher in the fields of agricultural machinery, waste management, industrial and municipal wastewater technology. He is interested in all environmental issues and his mechanical engineering studies were a stepping stone to various areas in which he later worked. He did his doctorate at the Humboldt University in Berlin in the field of agricultural machinery and then completed a six-month course at the University of Kassel about Methods of university didactics and scientific research.

In addition to Prof. Haboub's long academic experience, more than a quarter of a century, he was also active in the field of economics bringing theory and practice together. His work was also related to sustainability where participated in the development of a machine for shredding agricultural waste at one of the German universities, which was the entry into waste management. He gained the trust of scientists and business people in Germany and this was the gateway to his participation in the planning and construction of several industrial wastewater treatment plants outside of Germany. He gained the experience of managing engineering studies in the field of wastewater engineering through his work in the largest engineering office in Syria for several years. He worked as a visiting professor at the Weihenstephan-Triesdorf University in Bavaria.

During Prof. Haboub's career, he worked as a link between Germany and the Mediterranean countries in the academic and economic field by participating in the organization of the activities of the German-Syrian Environment Week for energy and sustainable environmental systems.

Prof. Haboub is currently working as a consultant at "the Arab Center for the Studies of Arid zones and Dry land – ACSAD.

Editorial Announcement

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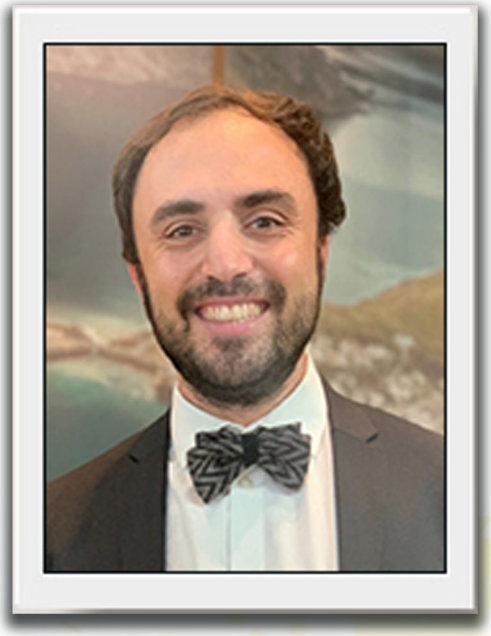

Dr. Hussam Hussein

Hussam Hussein is political scientist with a strong research interest in water and environmental policies, and a geographical focus on the Middle East and North Africa (MENA).

He is currently a Departmental Lecturer and Oxford Martin Fellow in International Relations at the Department of Politics and International Relations (DPIR) at the University of Oxford, member of the Middle East Centre (St. Anthony's College), and Fulford Junior Research Fellow at Somerville College, University of Oxford. During his PhD degree at the University of East Anglia, he investigated the discourse of water scarcity in the case of Jordan and its impacts on transboundary water governance.

During a research fellowship at the American University of Beirut, he investigated hydropolitics in the Levant and the role of refugees on water governance in the case of Lebanon and Jordan. Moreover, he adopted holistic approaches for the study of the water-energy-food nexus in the case of the MENA while working as a Research Associate at the Section of International Agricultural Policy and Environmental Governance, University of Kassel. His research focuses on the role of discourses in shaping water policies in the Middle East, on transboundary water governance and critical hydropolitics, and on issues related to the political economy of water resources in arid and semi-arid regions. His teaching experience include lectures, tutorials, and seminars in International Relations, Water Policy, and International Agricultural Policy. Before his PhD studies, he obtained a BA and MA in International Relations and Diplomacy from the University of Trieste – Gorizia (Italy), studied Middle Eastern Studies at SOAS, University of London, and obtained an MA in Interdisciplinary European Studies from the College of Europe.
He also worked for the Italian Embassy in Amman, Jordan, the European Parliament, and for the International Finance Corporation – World Bank, and as an international consultant for UNICEF and for BGR.

Thank you Reviewers

THE FUTURE OF FOOD JOURNAL
JOURNAL ON FOOD, AGRICULTURE & SOCIETY

FOFJ appreciates the efforts and experience of all its highly qualified reviewers who contribute to the science and quality of research. Therefore, FOFJ thanks all the reviewers who dedicate time, knowledge, and effort to improve the quality of submitted manuscripts.
In this issue, FOFJ would like to extend a sincere Thanks to the two ladys that were actively involved in this issue, **Dr. Seema Narayan**, and **Mrs. Ganna Tsimbolynets**, for their extraordinary contribution in reviewing articles for Vol 8 Nr 1 and 2. As FOFJ launches a new Call of Reviewers, we hope to continue working with experienced academics to provide the best for our readers and authors.

Ganna Tsimbolynets is a senior economic scientist with a strong research interest in (international economic relations/ influence of migration processes on sustainable development of territories) and a geographical focus on the Central and Eastern Europe. Mrs. Ganna is a lecturer and senior researcher at the Department of International Economic Relations in Uzhhorod National University (Ukraine). She is currently working as a project manager at CE "Agency of Regional Development and Cross-border Co-operational "Transcarpathia" of Zakarpattya Oblast Council," her specialization is projected to support sustainable environmental, social and economic development of the region.
During her work, she has implemented many international cooperation projects; namely, she was the manager of "Information Center for the fight against illegal and counterfeit pesticides" in the framework of Green Cross Switzerland project, UNEP. Now she is implementing the project "F(ol)low the Plastic from Source to the Sea: Tisa-Danube integrated action plan to eliminate plastic pollution of rivers," in the framework of Danube Transnational Programme. Her teaching experience includes lectures, seminars, tutorials in International Economic Relations. Before her PhD studies, she obtained a BA and MA in International Economic Relation from Uzhhorod National University and MA in International Relations from the University of Central Europe in Scalica (Slovak Republic).

Seema Narayan, PhD (Monash 2009)
Associate Professor of Economics
School of Economics, Finance and Marketing
RMIT University

Based at RMIT University, Melbourne Australia, Associate Professor Seema Narayan engage in inter-disciplinary research in the area of economics, with over 100 papers published in internationally recognised peer reviewed journals. According to Google Scholar, her H-index is 40, and i-10 index is 80. Seema Narayan serves as a Subject Editor at Emerging Markets Review and Journal of International Financial Markets Institutions and Money; as an Associate editor at Studies in Economics and Finance; and as a Topic Editor in Energies.