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Effect of *Moringa oleifera* Leaves and Seeds Powder Supplementation on Quality Characteristics of Cookies

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ABSTRACT

This study was aimed to produce of cookies enriched with moringa leaves powder (MLP), moringa seeds powder (MSP) and mixed of both of moringa leaves with seeds powders (MLP+MSP) at different concentrations (2.5, 5.0 and 7.5%), (2.5, 5.0 and 7.5%) and (2.5+2.5, 2.5+5.0 and 5.0+5.0 %), respectively. The effect of these substituted levels on chemical composition, physical and sensory characteristics of cookies was studied. The obtained results indicated that MLP was found to possess higher amount of protein, ash, crude fibers, dietary fibers and minerals, while MSP characterized by higher fat, protein, dietary fibers and minerals contents. Also, MLP and MSP contained a higher amount of essential and non-essential amino acids. Results also, showed that supplementation of MLP, MSP and mixed of MLP+MSP to processed cookies increased its content of protein, lipids, dietary fibers, essential and non-essential amino acids and minerals while carbohydrates content decreased compared to control cookies. As physical properties, MLP, MSP and mixed of MLP+MSP addition also caused gradually increased in weight of cookies values. While cookies volume and specific volume were gradually decreased by rising amount of substitution in compared to control sample. Also, the substituted of wheat flour (72% extraction rate) by MLP, MSP and mixed of MLP+MSP decreased the diameter and spread ratio of cookies while thickness increased. Generally, from this study it could be concluded that, the possibility of incorporating MLP, MSP and mixed of MLP+MSP in cookies up to (5.0, 5.0 and 2.5+5.0 %), respectively to improve the nutritional characteristics of cookies.

Keywords: Cookies - Moringa leaves powder - Moringa seeds powder - Chemical and Physical properties - Sensory evaluation.

INTRODUCTION

Recently, great interest is being placed on the utilization of the foods that not only feed the body but also used to be helpful in the prevention and treatment of diseases (AlKharusi *et al.*, 2009). This led to the present trend in nutrition which is the consumption of functional foods. Given the efforts made to decrease the incidence of diseases such as cancers, cardiovascular, coronary heart disease and to improve the health status, growth of foods rich in vegetables and anticancer compounds may play a main role in securing the health of consumers (Sidhu *et al.*, 2001). One such natural food source which can be used to improve functionality to other foods is *Moringa oleifera* (Sahay *et al.*, 2017).

Moringa Oleifera is one of the best medicinal plants which belongs to the Moringaceae family. The Moringaceae is a sole genus family, comprising thirteen species which known as a fast-growing tree that can reach a height of (5 – 10) m in 3 years, drought tolerant, grows in the tropical and subtropical areas is native to Indian, Southern America, Africa, Sub-Himalayan tracts, Asia and Middle East (Pandey *et al.*, 2011 and Pakade *et al.*, 2013).

Moringa Oleifera is popularly known as 'the miracle tree' which includes 46 natural antioxidants, 539 bio-chemical activities and 36 anti-inflammatories. Its an exceptionally good source of minerals, amino acids and vitamins. (Amjad *et al.*, 2015). Seeds, leaves and flowers are characterized by their high multiple therapeutic, nutritional and medicinal values, so it's widely used in traditional folk remedies in various countries (Singh and Prasad, 2013). Its leaves an excellent source of high nutrition value such as protein, total flavonoids content, total phenolics content, vitamins (B, C and A), minerals (Ca, Fe and Mg), essential amino acids and natural antioxidants, it act as antidiabetic and anticancer, so it can used to prevent various diseases such as liver diseases, malaria, supports the immune and digestion systems and cultivated in remote countries and malnutrition areas for its multiple medical and nutrition benefits (Vyas *et al.*, 2015 and Udikala *et al.*, 2017).

Moringa leaves is used raw such as a green salad or cooked as a lateral dish or as a nutrition major course. Moreover, they are dried and used powder in soups and sauces (Kiin-Kabari *et al.*, 2017). Moringa leaves are consider an excellent source of proteins, minerals (Ca, Fe, Mg and K), vitamins and total flavonoid content. In Africa, incorporation of moringa leaves in nursing mothers diets have been shown to enhance their milk production. Also, malnourished children have been shown to make significant weight gains when care givers add moringa leaves to their diet (Nwakalor, 2014).

Moringa seeds are a rich source of minerals (K, Mg and Zn), lipids, proteins, amino acids and antioxidant activity (Compaoré *et al.*, 2011 and Ijarotim *et al.*, 2013).

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In addition to its nutritional value, it also contains some medicinal properties which is important in many diseases such as treating hyperthyroidism, rheumatism simplex and acts as antimicrobial agents (Rockwood *et al.*, 2013). Moringa seeds are used for food seasoning or eaten as roasted nuts in some places and used in water purification (Ogunsina *et al.*, 2011and James and Zikankuba, 2017).

Balanced foods are numerous, including bakery products, which are ranked third (Kiharason *et al.*, 2017). Baked products can be fortified in various way to provide consumers therapeutic needs (Dachana *et al.*, 2010). Cookies are among the popular bakery products which ready-to-eat snack consumed extensively all over the world because it is ready to eat, cheap, rich nutritionally, availability in different tastes and have longer shelf life. The major ingredients flour, sugar, fat and water (Mohsen *et al.*, 2009). These are mixed together with other minor ingredients to form the dough Mamat *et al.*, (2010). Ogunsina *et al.*, (2011) investigated producing cookies samples using wheat and debittered moringa seeds flour mixtures had high nutritive values especially in protein, iron and calcium. (Ashoush and Mahdy, 2019) found that, processed a type of bakery product such as cookies using dried moringa leaves had high nutritive values especially in protein, crude fibers and minerals. Thus, supplementation of wheat flour with moringa leaves and seeds powders could significantly raise the nutritional value of wheat-moringa composite flour, especially in micro-nutrients.

So, this work is a trial to produce a type of herbal bakery products namely cookies, by using moringa leaves and seeds powders and study the effects of (MLP and MSP) on cookies characteristics including physical-chemical and sensory properties.

MATERIALS AND METHODS

Materials:

Moringa (*Moringa Oleifera)* leaves powder (MLP) and moringa seeds were obtained from National Research Centre (NRC), Dokki, Giza, Egypt.

Weak wheat flour (72% extraction rate), shortening, sugar, salt, baking powder and corn oil materials were obtained from local market (Fathalla Hypermarket), El-Mansoura city, El-Dakahlia Governorate, Egypt.

All chemicals used in this study for analysis were of analytical grade and were obtained from Al Gomhouria Company, El-Mansoura city, Egypt.

Methods:

Preparation of moringa seeds powder (MSP):

Matured moringa seeds were manually removed from the seed kernels and dried using air circulation dryer (GARBUIO - Treviso) at 50˚C for 19 hr at Food Industries Dept., Fac. of Agric., Mans.University. The dried seeds were ground in a clean Marlex blender. The moringa seeds powder was sieved using a sieve of 50 mesh size, to obtain a fine powder and kept in polyethylene bags until used it as mentioned by Bolarinwa *et al.*, (2017).

Preparation of flour blends:

Different flour blends were prepared by partially substituting of wheat flour (72% ext.) by moringa leaves and seeds powder according to the ratios as follows:

Table 1. Formulation of cookies supplemented with MLP and MSP

Treatments	Substitution levels %	Wheat flour (72% ext.) %
Control sample	0	100
MLP	2.5	97.5
	5.0	95
	7.5	92.5
MSP	2.5	97.5
	5.0	95
	7.5	92.5
Mixed of MLP+MSP	2.5+2.5	95
	2.5+5.0	92.5
	5.0+5.0	90

MLP: Moringa oleifera leaves powder.
MSP: Moringa oleifera seeds powder.

Preparation of Cookies:

Cookies samples were prepared from flour blends as mentioned in Table (1) beside control sample according to A.A.C.C. (2010). The cookies formula was 100 g flour, 28 g shortening, 58 g sugar, 0.9 g salt, 1.1 g baking powder and 22 ml water were weighed accurately. Cookies baking using the creaming method were carried out as described by Abdel-Samie and Abdulla (2014). Prepared dough was sheeted to a thickness of 7 mm and cut using a 59-mm diameter circular shape. Cookies were baked in a pre-heated oven at 205°C for 11 min. After baking, the cookies were cooled at room temperature and packed in air tight polythene bags.

Analytical methods:

Chemical analysis:

Moisture, ash, crude fibers, lipids and nitrogen contents were determined according to the method described in A.O.A.C. (2010).

Total carbohydrates were calculated by difference from the sum of the protein, fat, ash and crude fibers content.

Amino acids were determined according to A.O.A.C. (2010) using amino acid analyzer Eppendorf LC3000, Germany. EZ Chrom at Food Tech. Res. Institute, Agric. Res. Center, El-Giza, Egypt. While amino acid score were calculated according to FAO/ WHO Ref.

Minerals samples were prepared according to Chapman and Pratt (1978). The total quantities of iron, zinc, magnesium, sodium, calcium and potassium were determined by atomic absorption spectrophotometry. Whereas phosphorus was determined by spectrophotometer according to the method of Astm (1975) using Sens AA "GBC scientific equipment" model "Sens AA Dual" made in Dandenong, Victoria, Australia, Micro-Analysis unit, Faculty of Science, Mansoura University, El-Dakahlia Governorate, Egypt.

Total dietary fibers were measured according to A.O.A.C. (2010). Soluble and insoluble dietary fibers were determined according to method described by Prosky et al., (1988) at Food Tech. Res. Institute, Agric. Res. Center, El-Giza, Egypt.

Physical properties of cookies:

According to Emelike *et al.*, (2015). The diameter (D) and thickness (T) of six cookies were measured. Spread factor (CF) was calculated by dividing diameter of the cookies (cm) by their thickness (cm).

The weight of cookies was determined after cooling. The volume was measured by rape seeds displaced by six cookies. Specific volume was calculated by dividing volume (cm^3) by cookies weight (g) at Food Tech. Res. Institute, Agric. Res. Center, El-Giza, Egypt.

Sensory evaluation of cookies:

Cookies samples were left to cool at room temperature for an hour after baking and subjected to ten panelists from the Food Industries Department, Faculty of Agriculture, El-Mansoura University. Organoleptic evaluation for surface color, surface cracking pattern, crumb color, texture, mouth feel, flavor and overall acceptability were determined by the method as described by A.A.C.C. (2010).

Statistical analysis:

The obtained data were statistically analyzed using the producer of the SAS software system program (SAS, 2010). Analysis of variance was conducted using General Liner Model (GLM) procedure (Sendecor and Cochran, 1997). Means were separated using Duncan's test at a degree of significance ($P \leq 0.05$).

RESULTS AND DISCUSSION

Proximate chemical composition of raw materials:

Proximate chemical composition of wheat flour (72% ext.), moringa oleifera leaves powder (MLP) and moringa oleifera seeds powder (MSP) are presented in Table (2). The obtained results detected that, the highest value of crude protein and lipids were recorded for MSP (31.90%) and (28.69%), respectively followed by MLP (27.60%) and (2.58%), respectively than wheat flour (72% ext.). Meanwhile, MLP had the highest ash and crude fibers content followed by MSP. These results are in agreement with Ilyas *et al.,* (2015) who outline that, moringa seeds powder was found to possess higher lipid content was (30.94 %) than moringa leaves powder which contained (2.82 %). Also, El-Gammal *et al.,* (2016) found that MLP contained a high content of crude protein was (26.28 %) , ash (6.36 %) and crude fibers (18.20 %) .

Also, results presented in the above mentioned Table, it could be observed that, MLP and MSP contain high amount of K, Ca compared with those of wheat flour. They recorded (1341.29 and 809.32 mg/100g) for K as well as (3831.37 and 164.17 mg/100g) for Ca, respectively. Also, MLP and MSP have higher contents of micro-elements (Fe and Zn) than wheat flour, which in MLP were (28.76 and 1.98 mg/100g), while in MSP were (13.73 and 2.62 mg/100g), respectively. These results are in accordance with those obtained by Ilyas *et al.,* (2015) who declared that calcium was seven times higher in MLP (2100.7 mg/100g) than MSP (374.69 mg/100g). Also, Khalaf *et al.,* (2018) found that the minerals contents of MLP were 1652.18 Potassium, 464.10 Magnesium, 712.99 Phosphorous and 20.65 Iron (mg/100g).

Concerning the dietary fibers content presented in the same Table (2), MLP and MSP contain the highest percentage of total, soluble and insoluble dietary fibers which amounted in (39.48, 5.92 and 33.56 g/ 100 g dry weight basis) for MLP and (24.35, 7.88 and 16.47 g/ 100 g dry weight basis) for MSP, respectively. Alternatively, wheat flour (72% ext.) showed the lowest content of dietary fibers being (2.67 g/ 100 g dry weight basis). These results are in accordance with those obtained by Sakr *et al.,* (2012) and Mallillin *et al.,* (2014).

Table 2. Proximate chemical composition of raw materials

	Wheat flour (72% extraction)	MLP	MSP
Chemical composition (%)			
Moisture	10.19	7.86	4.30
Crude protein	9.40	27.60	31.90
Lipids	1.23	2.58	28.69
Ash	0.54	6.52	4.97
Crude fibers	0.58	17.86	5.26
Total carbohydrates	88.25	45.44	29.18
Minerals content (mg/100g dry basis)			
Potassium(K)	140.76	1341.29	3831.37
Calcium (Ca)	10.60	809.32	164.17
Magnesium (Mg)	22.82	146.96	561.57
Sodium (Na)	25.86	271.89	594.25
Phosphorus (P)	71.37	208.27	428.65
Iron (Fe)	0.69	28.76	13.73
Zinc (Zn)	0.46	1.98	2.62
Dietary fibers (g/100g dry weight basis)			
Total dietary fibers (TDF)	2.67	39.48	24.35
Soluble dietary fibers (SDF)	0.98	5.92	7.88
Insoluble dietary fibers (IDF)	1.69	33.56	16.47

MLP: Moringa oleifera leaves powder.
MSP: Moringa oleifera seeds powder.

Amino acids composition of raw materials:

Amino acids are organic compounds that join together to form proteins; as such, they effect the quantity and quality of protein. Amino acids are divided into essential and non-essential. In addition to their contribution to anabolic properties in human muscle, it acts as neurotransmitters, and some act as starting materials for the biosynthesis of neurotransmitters, hormones, and other important biochemical compounds (Swanepoel *et al.,* 2010 and Monajjemi *et al.,* 2014).

From the data given in Table (3) it could be noticed that, the amount of total essential amino acids content of MLP and MSP were relatively high total essential amino acids compared to wheat flour (72% ext.). It was (48.54 and 34.96 g / 100 g protein) for MLP and MSP, respectively compared to wheat flour (72% ext.) (31.70 g / 100 g protein). On the other hand, the leucine, isoleucine and lysine were higher in MLP and MSP being (18.90, 10.50 and 12.80 g/100g protein) and (15.20, 8.90 and 4.60 g/100g protein), respectively than those in wheat flour (72% ext.).

Also, MLP contained the higher amount of valine, threonine and phenylalanine compared to the others. Similarly, the amounts of non-essential amino acids of MLP and MSP were higher than those of wheat flour. On the other side, the glutamic acid, proline and arginine were higher in MSP compared to wheat flour (72% ext.). Also, the highest percentage of total amino acids content for MSP and MLP being (98.08 and 95.27 g/100g protein), respectively as compared to wheat flour (85 g/100g protein).

These results are in agreement with Melesse (2011) and Ijarotimi *et al.,* (2013) they found that MLP had needed nutritional balance of their values of essential amino acids, specifically; MLP is rich in lysine, which is considered the first limiting essential amino acid in cereals.

Table 3. Amino acids composition of different raw materials (g/100g protein) used in cookies preparing

Amino acids	Wheat flour (72% extraction)	MLP	MSP
Essential amino acids			
Leucine	5.90	18.90	15.20
Isoleucine	3.00	10.50	8.90
Lysine	2.30	12.80	4.60
Methionine	1.90	5.50	0.77
Cystine	2.70	4.30	1.47
Phenylalanine	4.30	14.50	1.16
Tyrosine	3.20	9.10	0.52
Therionine	2.30	10.00	0.70
Histadine	2.10	5.70	0.66
Valine	4.00	14.30	0.98
Total essential amino acids	31.70	48.54	34.96
Non- essential amino acids			
Alanine	3.00	1.61	1.18
Aspartic acid	4.50	2.38	1.09
Glutamic acid	25.50	26.50	38.90
Glycine	3.40	1.09	1.29
Proline	9.70	12.70	15.70
Serine	3.50	0.96	0.83
Arginine	3.70	1.49	4.13
Total non-essential amino acids	53.30	46.73	63.12
Total amino acids	85	95.27	98.08

MLP: Moringa oleifera leaves powder.
MSP: Moringa oleifera seeds powder.

Proximate chemical composition of cookies samples:

Proximate chemical composition of cookies samples prepared by using 100% wheat flour (72% ext.) as control and the other cookies samples are presented in Table (4). Data indicated that, cookies prepared from wheat flour substituted by increasing levels of MLP, MSP and mixed of MLP+MSP resulted in parallel increases of moisture and crude protein in all produced cookies which reached to (5.61 and 7.37 %) at 7.5 % of MLP , (5.24 and 7.69 %) at 7.5 % of MSP and (5.83 and 8.04 %) at 5.0+5.0% mixed of MLP + MSP, respectively compared with control sample (4.35 and 6.0 %), respectively. This behavior is due to the fact that MLP and MSP is rich in fibers content which increases water absorption and water holding capacity of moringa leaves and seeds powders. These results are in accordance with those found by (Ogunsina *et al*., 2011 and Mouminah, 2015) they reported that the substitution of wheat flour with MLP and MSP resulted in increase the protein, lipids, crude fibers and ash content of produced cookies samples except with decrease in the total carbohydrate contents.

Also, there were an increase in lipids, ash and crude fibers contents with increasing level of addition of MLP, MSP and mixed of MLP+MSP in all prepared cookies samples which reached to (24.95, 1.59 and 3.56 %) at 7.5 % of MLP,(26.91, 1.47 and 2.61 %) at 7.5 % of MSP and (26.58, 1.66 and 3.36 %) at 5.0+5.0% mixed of MLP + MSP, respectively in compared with control sample (24.85, 1.14 and 2.26 %), respectively.

In contrast, carbohydrates were decreased progressively when the MLP, MSP and mixed of MLP+MSP ratios increased in all cookies samples which reached to (62.53 %) at 7.5 % of MLP, (61.32 %) at 7.5 % of MSP and (60.36 %) at 5.0+5.0% mixed of MLP + MSP as compared to (65.75 %) for the control sample. These results are in accordance with those found by (Ogunsina *et al*., 2011; Abdel-Samie and Abdulla, 2014 and Tessera *et al*., 2015) they reported that gradual increases in dietary fibers content parallel to the increase in substitution level of moringa leaves and seeds powders in cookies.

Table 4. Proximate chemical composition of cookies samples (% on dry weight basis)

Cookies samples			Chemical composition (%)					
			Moisture	Crude protein	Lipids	Ash	Crude fibers	Total carbohydrates
Control sample			4.35	6.00	24.85	1.14	2.26	65.75
Substitution levels %	MLP	2.5	4.47	6.46	24.88	1.29	2.69	64.68
		5.0	5.08	6.91	24.92	1.44	3.12	63.61
		7.5	5.61	7.37	24.95	1.59	3.56	62.53
	MSP	2.5	4.40	6.56	25.54	1.25	2.38	64.27
		5.0	4.86	7.13	26.22	1.36	2.49	62.80
		7.5	5.24	7.69	26.91	1.47	2.61	61.32
	Mixed of MLP+ MSP	2.5%+2.5	4.65	7.02	25.57	1.40	2.81	63.20
		2.5%+5.0	5.32	7.58	26.26	1.51	2.93	61.72
		5.0%+5.0	5.83	8.04	26.58	1.66	3.36	60.36

MLP: Moringa oleifera leaves powder. **MSP: Moringa oleifera seeds powde** r.

Dietary fibers content of cookies samples:

Data in Table (5) show the dietary fibers content including total fibers, soluble fibers and insoluble fibers of produced cookies samples. From the obtained results it could be observed that, the dietary fibers content of all cookies samples were increasing by increasing in the substitution levels by (2.5, 5 and 7.5 %) of MLP, (2.5, 5 and 7.5 %) of MSP and (2.5+2.5, 2.5+5 and 5+5 %) mixed of MLP+MSP which reached to (5.60, 1.91 and 3.69 g/100g) at 7.5 % of MLP , (4.46, 1.52 and 2.94 g/100g) at 7.5 % of MSP and (5.76, 1.97 and 3.79 g/100g dry weight basis) at 5.0+5.0 % mixed of MLP+MSP, respectively compared with control sample (2.85, 0.98 and 1.87 g/100g dry weigh basis), for total fibers, soluble fibers and insoluble fibers respectively.

Finally, the data proved that moringa leaves and seeds powders can improve the dietary fibers content in cookies produced from wheat flour. This increase might be due to higher fibers content in moringa leaves and seeds powders Table (2). These results are in agreement with Ismael *et al*., (2016) and Mgbemena and Obodo (2016) they stated that moringa leaves and seeds powders are a great source of dietary fibers. Also, Abdel-Samie and Abdulla (2014) and Tessera *et al*., (2015) they reported that gradual increases in dietary fibers content parallel to the increase in substitution level of moringa leaves and seeds powders in cookies.

Table 5. Total, soluble and insoluble dietary fibers of cookies samples (g/100g dry basis)

Cookies samples			Total dietary fibers (TDF)	Soluble dietary fibers (SDF)	Insoluble dietary fibers (IDF)
Control sample			2.85	0.98	1.87
Substitution levels %	MLP	2.5	3.77	1.29	2.48
		5.0	4.68	1.60	3.08
		7.5	5.60	1.91	3.69
	MSP	2.5	3.39	1.16	2.23
		5.0	3.93	1.34	2.59
		7.5	4.46	1.52	2.94
	Mixed of MLP+MSP	2.5+2.5	4.30	1.46	2.84
		2.5+5.0	4.84	1.65	3.19
		5.0+5.0	5.76	1.97	3.79

MLP: Moringa oleifera leaves powder.
MSP: Moringa oleifera seeds powder.

Minerals content of cookies samples:

Minerals are important for certain physicochemical processes which are essential to human life. Per day, greater than 100 mg of the macro-minerals (Na, Mg, K, Ca, P and Cl) and less than 100 mg of micro-minerals (Fe, Cu and Zn) are required (Soetan *et al*., 2010).

As shown in the Table (6), the minerals content were gradually increased by the increasing level of substitution with (2.5, 5.0 and 7.5) % of MLP where K, Mg, Na, P and Zn of blend 7.5 % being (133.76, 21.54, 48.29, 83.51 and 0.31 mg/100g), respectively in compared with control sample (35.85, 11.37, 30.36, 73.40 and 0.17 mg/100g), for the same minerals respectively. Also, the partial substituted of wheat flour with (2.5, 5.0 and 7.5) % of MSP increased the minerals content while K and Mg content of blend 7.5 % were increased by(9 and 5) folds (320.51 and 52.65 mg/100g), respectively in comparing with control sample (35.85 and 11.37 mg/100g). Whereas, Ca, Na, P, Fe and Zn content of blend 7.5 % were increased two folds being (24.60, 72.65, 100.34, 2.37 and 0.35 mg/100g), respectively comparing with control one.

In addition, the increasing of substitution levels by (2.5+2.5, 2.5+5.0 and 5.0+5.0 %) mixed of MLP+MSP was accompanied by gradual increase in minerals content (K, Ca, Mg, Na, P, Fe and Zn) for all cookies samples which reached to (290.88, 61.24, 45.66, 70.61, 97.80, 3 and 0.38 mg/100g), for blend 5.0+5.0 % mixed of MLP+MSP respectively as compared to control sample. In the same time, the highest values of Ca and Fe were found in 7.5 % of MLP cookies sample being (75.03 and 3.05 mg/100g), respectively as compared to the control sample and the other cookies samples. However, cookies sample with 7.5 % of MSP recorded the highest values of minerals content (K, Mg, Na and P) as compared to the control sample and the other cookies samples.

Table 6. Minerals content of cookies samples (mg/100g on dry weight basis)

Cookies sample			Potassium (K)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Phosphorus (P)	Iron (Fe)	Zinc (Zn)
Control sample			35.85	13.28	11.37	30.36	73.40	0.98	0.17
Substitution levels %	MLP	2.5	68.49	33.18	14.76	36.40	76.82	1.67	0.22
		5.0	101.12	52.67	18.15	42.73	80.43	2.36	0.26
		7.5	133.76	75.03	21.54	48.29	83.51	3.05	0.31
	MSP	2.5	130.38	17.52	25.13	44.57	82.27	1.30	0.23
		5.0	225.64	20.83	38.78	58.46	91.16	1.94	0.29
		7.5	320.51	24.60	52.65	72.65	100.34	2.37	0.35
	Mixed of MLP+MSP	2.5+2.5	163.37	36.95	28.52	50.52	85.65	1.99	0.28
		2.5+5.0	258.26	40.72	42.27	64.39	94.52	2.31	0.34
		5.0+5.0	290.88	61.24	45.66	70.61	97.80	3.00	0.38

MLP: Moringa oleifera leaves powder. **MSP: Moringa oleifera seeds powder.**

Consequently, addition of MLP and MSP can improve mineral contents of cookies produced from wheat flour which is poor in mineral contents. This increase in minerals contents may be attributed to higher major and micro elements content in both of MLP and MSP These results are approximately similar to those obtained by Tessera *et al*., (2015) and Bolarinwa *et al*., (2017) they outline that, as the proportion of MLP and MSP increased in the flour blends of cookies samples, the mineral contents also, increased such as K, Mg, Ca and Fe.

Amino acids composition of cookies samples:

Amino acids content of cookies samples presented in Table (7), the total amino acids content was gradually increased by increasing of substitution levels up to 7.5 % of MLP, 7.5 % of MSP and 5.0+5.0 % mixed of MLP+MSP in cookies samples being (54.85, 55.17 and 57.64 g/100g protein), respectively compared with control sample (51.80 g/100g protein).

Among all the essential amino acids content, the leucine, isoleucine and lysine were found to be of the highest values by increasing of substitution levels up to 7.5 % of MLP, 7.5 % of MSP and 5.0+5.0 % mixed of MLP+MSP in cookies samples recorded (4.84, 2.45 and 1.98 g/100g protein), (4.56, 2.33 and 1.36 g/100g protein) and (5.04, 2.59 and 1.86 g/100g protein), respectively compared with control sample (3.70, 1.80 and 1.10 g/100g protein), for the same amino acids respectively.

On the other hand, the amounts of non-essential amino acids analyzed, the proline and glutamic acid score recorded a slight differences by increasing of substitution levels up to 7.5 % of MLP, 7.5 % of MSP and 5.0+5.0 % mixed of MLP+MSP in cookies samples which reached to (6.60 and16.33 g/100g protein), (6.82 and 17.26 g/100g protein) and (6.91 and 18.61 g/100g protein), respectively compared with control sample (6.10 and 15.50 g/100g protein). Also, arginine content noted simple differences between control sample being (2.10 g/100g protein) and by increasing of substitution levels up to 7.5 % of MSP and 5.0+5.0 % mixed of MLP+MSP cookies samples being (2.25 and 2.17 g/100g protein), respectively. The increased in amino acids content of cookies samples greatly due to the higher amino acids content in moringa leaves and seeds powders.

Finally, it may be concluded that the addition of moringa leaves and seeds powders to cookies flour improve its nutritional value as amino acids content of wheat cookies. These results are in agreement with Mohammed Nour *et al.*, (2016) and Sahay *et al.*, (2017) they found that moringa leaves and seeds powders had a well-balanced complement of essential and non-essential amino acids content which were riched in lysine, isoleucine, leucine, valine, proline and glutamic acid.

Table 7. Amino acids composition of cookies samples (g/100g protein)

Amino Acids	Cookies samples									
	Substitution levels									
	Control sample	MLP			MSP			Mixed of MLP+MSP		
	100 %	2.5 %	5%	7.5%	2.5 %	5 %	7.5 %	2.5+2.5%	2.5+5%	5+5%
Essential amino acids										
Leucine	3.70	4.08	4.46	4.84	3.99	4.28	4.56	4.37	4.66	5.04
Isoleucine	1.80	2.02	2.24	2.45	1.98	2.16	2.33	2.20	2.37	2.59
Lysine	1.10	1.39	1.69	1.98	1.19	1.28	1.36	1.48	1.57	1.86
Methionine	1.20	1.16	1.13	1.09	1.17	1.14	1.11	1.13	1.10	1.15
Cystine	1.60	1.57	1.54	1.51	1.60	1.58	1.56	1.57	1.56	1.54
Phenylalanine	2.60	2.57	2.54	2.51	2.56	2.53	2.49	2.53	2.50	2.47
Tyrosine	1.70	1.68	1.66	1.64	1.67	1.64	1.61	1.65	1.62	1.60
Therionine	1.40	1.39	1.38	1.37	1.38	1.37	1.35	1.37	1.36	1.35
Histadine	1.20	1.18	1.17	1.15	1.19	1.17	1.16	1.17	1.16	1.14
Valine	2.80	2.77	2.73	2.70	2.76	2.71	2.66	2.72	2.68	2.64
Total essential amino acids	19.10	19.81	20.54	21.24	19.49	19.86	20.19	20.19	20.58	21.38
Non-essential amino acids										
Alanine	2.10	2.09	2.08	2.06	2.08	2.05	2.03	2.07	2.04	1.98
Aspartic acid	2.70	2.69	2.62	2.54	2.66	2.62	2.58	2.65	2.61	2.60
Glutamic acid	15.50	15.78	16.05	16.33	16.09	16.67	17.26	16.36	16.95	18.61
Glycine	2.00	1.98	1.96	1.93	1.98	1.97	1.95	1.96	1.94	1.92
Proline	6.10	6.27	6.43	6.60	6.34	6.58	6.82	6.51	6.75	6.91
Serine	2.20	2.17	2.14	2.11	2.17	2.13	2.09	2.14	2.10	2.07
Arginine	2.10	2.08	2.06	2.04	2.15	2.20	2.25	2.13	2.19	2.17
Total non-essential amino acids	32.70	33.06	33.34	33.61	33.47	34.22	34.98	33.82	34.58	36.26
Total amino acids	51.80	52.87	53.88	54.85	52.96	54.08	55.17	54.01	55.16	57.64

MLP: Moringa oleifera leaves powder. **MSP: Moringa oleifera seeds powder.**

Physical measurements of cookies samples:

Results presented in Table (8) showed that, the partial substituted of wheat flour (72% ext.) with (2.5, 5 and 7.5 %) of MLP or MSP and (2.5+2.5, 2.5+5.0 and 5.0+5.0%) mixed of MLP+MSP increased the weight of cookies gradually in parallel with increasing the level of substitution. The increasing in cookies weight may be due to the increase in fiber contents which characterized by contained higher water holding capacity as mentioned by (Mckee and Latner, 2000 and Summaya and Sonkar, 2016).

On the other side, substituted caused gradually decreased in cookies volume and specific volume by increasing level of substitution in compared to control sample. The high decrement in volume that obtained with MLP, MSP and mixed of MLP+ MSP may be due to the high fibers content of MLP and MSP (Table,2).

Also, from the same table, it could be revealed that results of the diameter (cm) and spread ratio of cookies recorded a little decreased by the increasing amount of substitution level, while result of thicknesses noted that there were a little increase as compared with control cookies sample. These results are similar to those obtained by (Dachana *et al.*, 2010; Ogunsina *et al.*, 2011 and Abdel-Samie and Abdulla, 2014) they found that, the addition of MLP and MSP adversely affected on thickness and diameter, and therefore the spread ratio of the substituted cookies which reduced spread ratios in cookies blends were ascribed to dilution of gluten and the fact that composite flours seemingly form aggregates with increased numbers of hydrophilic sites available for competing the limited free water in cookies dough.

Table 8. Physical measurements of cookies samples:

Cookies samples			*Physical measurement					
			Weight (g)	Volume (cm^3)	Specific volume (cm^3/g)	Diameter "D" (cm)	Thickness "T" (cm)	Spread ratio (D/T)
Control sample			14.25^{c}	22.80^{a}	1.60^{a}	6.10^{a}	0.80^{b}	7.63^{a}
Substitution levels %	MLP	2.5	14.81^{c}	22.10^{ab}	1.49^{ab}	5.90^{a}	0.89^{b}	6.63^{a}
		5.0	15.23^{bc}	21.50^{b}	1.41^{ab}	5.80^{ab}	0.91^{ab}	6.37^{ab}
		7.5	16.54^{b}	20.30^{bc}	1.23^{bc}	5.70^{b}	0.94^{ab}	6.06^{ab}
	MSP	2.5	15.40^{bc}	22.40^{a}	1.46^{ab}	5.95^{a}	0.89^{b}	6.69^{a}
		5.0	16.56^{b}	21.90^{b}	1.32^{b}	5.80^{ab}	0.93^{ab}	6.24^{ab}
		7.5	17.72^{ab}	21.60^{bc}	1.22^{bc}	5.70^{b}	0.97^{a}	5.88^{b}
	Mixed of MLP +MSP	2.5+2.5	14.83^{c}	21.80^{b}	1.47^{ab}	6.00^{a}	0.90^{ab}	6.67^{a}
		2.5+5.0	15.65^{bc}	20.60^{bc}	1.32^{b}	5.65^{b}	0.96^{a}	5.89^{ab}
		5.0+5.0	18.04^{a}	19.70^{c}	1.09^{c}	5.50^{b}	1.07^{a}	5.14^{b}

Means followed by different letters in the same column are significantly different by Duncan's multiple test (p<0.05).
MLP: Moringa oleifera leaves powder. **MSP: Moringa oleifera seeds powder.**

Sensory evaluation of cookies samples:

From the obtained date in Table (9), it could be concluded that there were significant differences between the control and cookies samples prepared from (2.5, 5.0 and 7.5%) level of substitution by MLP in sensory characteristics, except samples containing 2.5 and 7.5 % of MLP were acceptable to panelists in texture. Significant decrease ($p<0.05$) for crust and crumb color could were observed may be due to the green color of the cookies imparted by the chlorophyll content of moringa leaves powder which affect negatively to consumers. The decrease for flavor of the prepared cookies samples could be ascribed to herbal of the moringa leaves powder. The acceptability of all cookies samples decreased with the increasing level of MLP supplementation. Acceptable quality could be observed by incorporating moringa leaves powder up to 5.0 % in cookies samples. These results are in approximately similar with (Dachana *et al.,* 2010 and Mouminah, 2015) they reported that incorporation of MLP in cookies caused relatively greenish and dark color of the crust and crumb.

On the other hand, the results in the same table showed that, there were no significant differences of surface cracking pattern , crumb color and flavor could be extended to substitution level of 2.5 and 5.0 % of MSP as compared with control sample, while significant differences was recorded at 7.5% level of substitution. Also, there were no significant differences between control sample and cookies samples, which substituted with 2.5, 5.0 and 7.5% MSP for surface color, but there was significant difference of substitution level of 5.0 % MSP for texture, mouth feel and overall acceptability. The significant increase ($p<0.05$) for flavor, crumb color and surface color may be due higher lipids content of moringa seeds powder which improve color and increase palatability of food. Acceptable quality could be obtained by incorporating MSP up to of 5.0 % in cookies samples.

Concerning to substitution of wheat flour by MLP+ MSP, there were significant differences between the control sample and cookies prepared with (2.5+2.5, 2.5+5.0 and 5.0+5.0 %) level of substitution with mix the MLP+MSP in most sensory characteristics with exception. The texture in these prepared samples and surface cracking pattern in (2.5+2.5 and 2.5+5.0%) level of substitution which were acceptable to panelists. The significant increase ($p<0.05$) for texture and surface cracking pattern could be ascribed to higher lipids content of moringa seeds powder.

The significant decrease ($p<0.05$) for crumb and surface color could be due to the green color of the cookies as a result of addition moringa leaves powder. Acceptable quality cookies could be obtained by incorporating mixed of MLP+MSP up to 2.5+5.0 %. These results are in accordance with those found by Ogunsina *et al.,* (2011) reported that the addition of MSP to cookies resulted in improvement of its palatability due to its higher lipids content of MSP. Also, no significant differences were found in the acceptability of the cookies fortified with MSP in compare with the control one.

Table 9. Sensory characteristics of cookies samples prepared with MLP and MSP:

Cookies samples			Surface Color (10)	Surface cracking pattern (10)	Crumb Color (10)	Texture (10)	Flavor (10)	Mouth feel (10)	Overall acceptability (60)
Control sample			9.60±0.66^{a}	9.28±0.93^{a}	9.48±0.84^{a}	9.12±0.88^{a}	9.42±0.66^{a}	9.38±0.81^{a}	56.28±4.36^{a}
Substitution levels	MLP	2.5%	8.90±0.97^{b}	8.55±1.04^{b}	8.55±0.83^{b}	8.84±0.94^{a}	8.22±1.03^{b}	8.37±0.96^{b}	52.23±4.36^{b}
		5.0%	8.53±1.03^{b}	8.63±1.05^{b}	8.22±1.24^{b}	8.86±0.89^{a}	8.03±0.92^{b}	7.83±1.16^{c}	50.10±5.38^{b}
		7.5%	7.24±1.32^{c}	7.86±1.38^{c}	6.82±1.35^{c}	8.10±1.18^{b}	7.08±1.15^{c}	6.75±1.37^{d}	43.85±5.66^{c}
	MSP	2.5%	9.35±0.94^{a}	9.34±0.67^{a}	9.62±0.66^{a}	9.49±0.67^{a}	9.35±1.06^{a}	9.20±1.23^{a}	56.35±4.32^{a}
		5.0%	9.48±0.94^{a}	9.12±0.99^{a}	9.36±1.25^{ab}	8.85±1.49^{b}	8.65±1.25^{ab}	8.19±1.39^{b}	53.55±6.78^{b}
		7.5%	9.45±0.96^{a}	8.60±1.07^{b}	9.10±1.20^{b}	8.54±1.42^{b}	7.90±1.43^{b}	6.94±1.02^{c}	50.53±6.04^{c}
	Mixed of MLP +MSP	2.5%+2.5%	8.30±0.82^{b}	8.90±1.20^{a}	7.95±1.12^{b}	8.40±1.15^{a}	7.40±1.51^{b}	7.45±1.67^{b}	48.40±6.08^{b}
		2.5%+5.0%	8.20±0.95^{b}	8.69±1.04^{a}	7.92±0.88^{b}	8.50±1.11^{a}	7.50±1.35^{b}	7.45±1.42^{b}	48.26±4.79^{b}
		5.0%+5.0%	7.10±1.60^{c}	7.80±1.48^{b}	6.90±1.79^{c}	8.12±1.85^{a}	6.45±1.38^{c}	6.50±1.27^{c}	42.87±5.95^{c}

Means followed by different letters in the same column are significantly different by Duncan's multiple test ($p<0.05$).
MLP: Moringa oleifera leaves powder. **MSP: Moringa oleifera seeds powder.**

CONCLUSION

Finally, it could be clearly that the possibility to enhance nutritional value of bakery products such as moringa oleifera leaves and seeds powders with different ratios could enhance nutritional value of bakery products and resulted in notable increased important nutrients for human health such as (dietary fibers, minerals (Fe, Ca, K and Zn), protein and fat). Also, addition of MLP and MSP to cookies could raise the essential and non-essential amino acids such as (leucine, isoleucine, glutamic acid, proline and lysine), which have a great nutritional advantage to developing countries and could help in reducing malnutrition diseases.

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تأثير التدعيم بمسحوق أوراق وبذور نبات المورينجا علي خصائص جودة الكوكيز

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تهدف هذه الدراسة إلى إنتاج الكوكيز المدعم بمسحوق أوراق المورينجا ،مسحوق بذور المورينجا وخليط من مسحوق أوراق وبذور المورينجا بتركيزات مختلفة (٢,٥، ٥ و ٧,٥ ٪) ، (٢,٥، ٥ و ٧,٥ ٪) و(٢,٥+٢,٥، ٢,٥+٥ و ٥+ ٥ ٪) ، علي التوالي. تم دراسة تأثير هذه الإضافة علي التركيب الكيميائى ، الصفات الفيزيائية و الصفات الحسية للكوكيز. ولقد أوضحت نتائج التحليل الكيميائى احتواء مسحوق أوراق المورينجا على نسبة عالية من الرماد ، الألياف الخام ، الألياف الغذائية والمعادن (البوتاسيوم ، الكالسيوم ، الحديد ، الزنك) بينما يتميز مسحوق بذور المورينجا بزيادة محتواه من الدهون ، البروتين ، الألياف الغذائية والمعادن (البوتاسيوم ، الماغنسيوم ، الصوديوم ، الفوسفور، الزنك). وأيضا لوحظ ارتفاع محتوي كلا من مسحوق أوراق المورينجا و بذور المورينجافى الاحماض الأمينية الاساسية وغير الأساسية مثل (ليوسين ، ليسين ، إيزوليوسين ، برولين وحمض الجلوتاميك)، وأوضحت النتائج أيضا أن زيادة نسبة الاستبدال من مسحوق أوراق المورينجا ، مسحوق بذور المورينجا و مسحوق أوراق وبذور المورينجا لإنتاج الكوكيز أدي إلى زيادة محتوي البروتين ، الدهون ،الرماد ، الألياف الغذائية ، الأحماض الأمينية الأساسية وغير الأساسية مثل (الليوسين ، الليسين ، الإيزوليوسين ، برولين وحمض الجلوتاميك) والمعادن مثل (البوتاسيوم ، الماغنسيوم ، الحديد ، الكالسيوم ، الصوديوم ، الفوسفورو الزنك) بينما انخفض محتوي الكربوهيدرات. وأوضحت نتائج الصفات الفيزيائية، أن الاستبدال أدي إلى زيادة تدريجية فى الوزن، بينما انخفض كلا من الحجم والحجم النوعى للكوكيز بشكل تدريجى بزيادة نسبة الاستبدال مقارنة بالعينة الكنترول. وأيضا أدي هذا الأستبدال إلي انخفاض تدريجي لكلا من القطر ونسبه الافتراش لعينات الكوكيز بينما لوحظت زيادة تدريجية في السمك. نستخلص من هذه الدراسة إلى إمكانية تصنيع كوكيز مدعم بمسحوق أوراق المورينجا أو مسحوق بذور المورينجا أو خليط منهما وذلك بنسب استبدال تصل إلي (٥، ٥، ٢,٥+٥ ٪) علي التوالي وذلك لتحسين القيمة التغذوية والصفات الحسية للكوكيز الناتج.

الكلمات الدالة : الكوكيز - مسحوق أوراق المورينجا - مسحوق بذور المورينجا - الخصائص الكميائية و الفيزيائية - التقييم الحسي.