PREPARATION AND EVALUATION OF INSTANT NOODLES SUPPLEMENTED WITH NATURAL SOURCES OF HIGH LYSINE CONTENT

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Abstract

Moringa leaf powder (MLP) and Chickpea seed powder (CSP) are good sources of protein (30.15% and 24.5% res.), also, MLP has high crude fibre (16.2%) and ash (12.85%) contents which are vital for human nutrition and maintains a good health. Wheat flour (WF) has lower crude protein (10.18%), ash (0.63%) and crude fiber (0.75%) contents than MLP and CSP. MLP appear to be a rich source of calcium, iron, zinc, and magnesium. CSP rich source of Zinc and magnesium, and it contains considerable amounts of iron. Whereas WF showed mineral contents lower than MLP and CSP. Beside, MLP and CSP are of high favorable amino acid balance, and considered good sources of lysine (5.71 and 6.89 g amino acid per 100g protein res.). MLP and CSP proteins showed higher total amounts of essential amino acids than the FAO/WHO/UNU (1985) recommended pattern. Supplementation of wheat flour with MLP and CSP produced noodles of high protein content and improved nutritional value of noodles, particularly the content of lysine, improved its color and also to provided decorated food (green-colored noodles) to the consumer. Noodles were supplemented with MLP (at 2.5%, 5% and 7.5% levels) and CSP (at 7.5%, 10%, 12.5% and 15% levels). Noodles were well accepted until supplementation levels 5% MLP and 12.5% CSP to wheat flour.

INTRODUCTION

Over 143 million children under the age of five in developing countries were undernourished in 2006. Protein deficiency plays a part in the disease kwashiorkor, and lead to reduced intelligence or mental retardation. Amino acids affect the function of other nutrients in the body such as presence of lysine, which ensures adequate calcium absorption and aids in the antibodies production. (Moyo et. al., 2011).

Protein and essential amino acids which are very important for combat malnutrition problem can be found in *Moringa oleifera* leaves**.** In Africa there is the ability to grow and utilize an edible plant, Moringa commonly referred to as "The Miracle Tree". Moringa or the horseradish tree, is a pan-tropical species**,** it can be grown in a variety of soil conditions. It consider as one of the World's most useful trees for food, medication and industrial purposes, and improve diets and health**.** This tree was utilized by the ancient Romans, Greeks and Egyptians. Leaves are eaten as greens, in salads, vegetable curries, and as pickles. It can be eaten fresh, cooked, or stored as dried powder without refrigeration. It used as a protein supplement. Leaves are of high nutritive value, rich in vitamins, minerals with an excellent amino acid profile**.** It used to combat malnutrition, especially among infants and nursing mothers (Moyo et. al., 2011). Dietary consumption of its leaves is therein promoted as a strategy of personal health preservation and self-medication in various diseases, it has hypocholesterolemic, and anti-diabetic. It can protect against Alzheimer's disease and hase potent antioxidant (Das et. al., 2012).

Legumes are recognized as the best source of vegetable protein, it consider as functional ingredients for food formulation (Abou Arab et. al., 2010). Chickpea (*Cicer arietinum*) is one of the most important crops in the world because of its nutritional quality. In Egypt chickpea seed are usually consumed at the raw green and tender stage, called Malana, or as a popular snack food. The dry seeds can also be consumed after cooking and processing in different ways. Chickpea flour is used as a supplement in weaning food mixes, bread and biscuits. Chickpea demonstrated potentially beneficial changes to the glycaemic response, improve liver and kidney functions. It has anticancer and anti-cardiovascular diseases activities (Abou Arab et. al., 2010).

Pasta and spaghetti were fortified with chickpea. Pasta is traditional and highly popular cereal-based food product because of its convenience nutritional quality and palatability. Pasta is deficient in lysine common to most cereal products, consequently, legumes and cereals are nutritionally complementary (Abou Arab et. al., 2010).

Instant noodles is deficient in lysine common to most cereal products. Therefore, moringa leaf and chickpea seed are rich in protein, high in lysine, thus, they can be used to fortify cereals to produce a complementary food with nutritional quality. It is upon this background that this study sought to preparation and evaluation of instant noodles supplemented with moringa leaf and chickpea seed as natural sources high in lysine

MATERIALS AND METHODS

Materials

1- Wheat flour (72%) was obtained from Milling Company, Dakahila, Egypt.

2- Chickpea (*Cicer arietinum*) seeds were purchased from the local market. Seeds were ground up to pass through 100 mesh screen sieve, and the powdered samples were kept in polyethylene bags until used.

3- Moringa (*Moringa oleifera*) leaves were obtained from National Research Centre, Dokki, Cairo, Egypt, leaves were dried, ground up to pass through 100 mesh screen sieve, and the powdered samples were kept in polyethylene bags until used.

4- Chemicals used in this study were purchased from El-Gomhoria Company, Egypt.

Methods

Analytical methods

Moisture, crude protein, ether extract, crude fiber, ash, and Chlorophyll were determined as described in A.O.A.C. (2005). While total carbohydrates were calculated by differences.

Minerals determined

Calcium (Ca), Iron(Fe), Zinc (Zn) and magnesium (Mg) were determined according to the method described by A.O.A.C. (2005) using The perkin Elmer 3300 (USA) atomic absorption.

Protein quality

The amino acid composition was determined according to the method of Duranti and Cerletti (1979) by using amino acid analyzer (Beckman amino acid analyzer, Model 119 CL).Tryptophan content was determined colorimetrically, following the method of Miller (1967). Chemical score of essential amino acids were calculated using the equation of Pellet and Young (1980). PER was calculated as given by Alsmeyer *et. al.* (1974). Biological Value (BV) was calculated as described by Farag et. al., (1996).

Noodles preparation

Instant noodles were prepared according to Rho *et. al.* (1986) and Bhattacharya *et. al.* (1999). Different blends were prepared to obtain (7) formulas and control (100% wheat flour). The wheat flour (72%) was supplemented with moringa leaf powder (MLP) at (2.5%, 5%, and 7.5%) levels and supplemented with chickpea seed powder (CSP) at (7.5%, 10%, 12.5% and 15%) levels. The blends were mixed well. A laboratory noodles machine was used to sheet and cut the dough. The initial sheet was formed by passing the dough through the rolls set at a gap. The final dough sheet was reduced to a final thickness of 1-5 mm. The final dough sheet was cut by hand into 30 cm long sheets. These sheets where subjected to steam for (5 min), then these samples were fried at 180^{o}C for 10 sec.

Determination of cooking quality

Noodles were put into boiled water and cooked for 3 min, then rinsed and cooled in running cold tap water for 1 min. Cooking loss was measured by evaporating the cooking water to dryness in oven at 100 ^{o}C as described in A.A.C.C. (2000)

Sensory evaluation of cooked noodles

Sensory evaluation of cooked noodles were evaluated for various quality attributes such as color, taste, texture and overall acceptability on a 1 to 10 hedonic scale as described by (Jayasena et. al., 2008)

Statistical analysis.

The data were statistically analyzed using the analysis of variance as out lined by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Chemical composition of wheat flour (72% extraction), moringa leaf powder (MLP) and Chickpea seed powder (CSP).

Data given in Table (1) represent values of crude protein, ether extract, ash, crude fiber, and total carbohydrates on dry weight basis, for wheat flour (WF), moringa leaf powder (MLP) and Chickpea seed powder (CSP). Data given in Table (1) showed that wheat flour has lower crude protein (10.18%), ash (0.63) and crude fiber (0.75) contents than MLP and CSP. WF has high total carbohydrates (87.72%). MLP is high in crude protein (30.15%), crude fibre (16.2%) and ash (12.85%) contents. In addition to, a moderate fat content (4.95%) and total carbohydrate (35.85%). These results are in agreement with those reported by (Moyo et. al., 2011).

Plant food that provides more than 12% (dry basis) of its caloric value from protein is considered a good source of protein. Therefore, Moringa leaves not only meet but even more than this requirement. Moringa leaf showed relatively high crude protein making it a suitable ingredient for malnutrition diets, and making it a suitable functional ingredient for improving nutritional and organoleptic properties of food products. Moringa leaves could serve as a protein supplementary source in human diets to improve health and nutrition (Moyo et. al., 2011).

The data presented in Table (1) revealed that, chickpea (CSP) has high protein content (24.5%) and considerable amounts of fat (5.55%). On the other hand, it has moderat ash content (3.69%), crude fiber (4%) and contain high level of carbohydrate (62.26%). Chemical composition of chickpea proved that it is an excellent protein source. These results are in agreement with those reported by (Abou Arab et. al., 2010 and Alajaji and El-Adawy, 2006). It can be concluded that MLP and CSP are excellent food material with a high nutritional value. Results which suggest that MLP and CSP could be considered good sources of protein, suitable for enriching wheat flour.

Table 1. Chemical composition of wheat flour (72% ext.), moringa leaf powder (MLP) and chickpea seed powder (CSP), (on dry weight basis).

Component %	Wheat flour (72% ext.)	MLP	CSP
Crude protein	10.18	30.15	24.5
Ether extract	00.72	4.95	5.55
Ash	00.63	12.85	3.69
Crude fiber	00.75	16.20	4.00
Total carbohydrates	87.72	35.85	62.26

Carbohydrates were calculated by difference.

Iron is required in all tissues of the body for basic cellular functions, and is critically important in muscle, brain and red blood cells. Calcium is an essential nutrient that plays a vital role in neuromuscular function, many enzyme-mediated processes, blood clotting, and providing rigidity to the skeleton. In children an extra input is needed to cover the requirements of skeletal growth (FAO/WHO, 2002). Zinc is essential for the synthesis of DNA, RNA, insulin and function and/or structure of several enzymes. Zinc is also required for cell reproduction and growth especially sperm cells. In addition, Zn is known for its anti-viral, antibacterial, anti-fungal and anti-cancer properties. Moringa minerals composition plays a significant role in nutritional, medicinal and therapeutic values (Moyo et. al., 2011).

Data given in Table (2) represent values of calcium (Ca), iron (Fe), zinc (Zn) and magnesium (Mg) for MLP, CSP and WF on dry weight basis. Data in Table (2) showed that MLP appear to be a rich source of calcium (3550 mg/100gm), iron (53 mg/100gm), zinc (3.05 mg/100g) and magnesium (565 mg/100g) relative to the recommended daily dietary allowances for children from 6 to 59 months of age (10 mg/day, 500-600 mg/day, 4.1 mg/day and 76 mg/day for iron, calcium, zinc and magnesium respectively) (FAO/WHO 2002). Results are in a good agreement with that reported by (Moyo et. al., 2011). Also, CSP appear to be a rich source of Zinc (4.1 mg/100g) and magnesium (175 mg/100g), and it contain considerable amounts of iron (7.83 mg/100gm), also it contain 200 mg/100g calcium. Whereas WF showed mineral contents lower than MLP and CSP. Results are in a good agreement with that reported by Alajaji and El-Adawy (2006).

Data in Table (2) also showed that MLP appear to be a rich source of chlorophyll, it contain total chlorophyll 660mg/100g(on dry weight basis)

Table 2. Minerals contents of wheat flour (72% ext.), moringa leaf powder (MLP) and chickpea seed powder (CSP) and chlorophyll content of MLP (on dry weight basis).

Minerals (mg/100g)	Wheat flour	MLP	CSP
Ca	48.0	3550	200
Fe	0.94	53.00	7.83
Zn	0.72	3.050	4.1
Mg	0.30	565.0	175
chlorophyll	-	660	-

Amino acid composition of wheat flour (72%ext.) (WF), moringa leaf powder (MLP) and Chickpea seed powder (CSP).

The amino acid requirements are the logical Yard-sticks by which protein quality can be measured, and the relative quantities of the various amino acids, in particular the essential amino acids, in the food could be used as reliable estimators of actual protein quality (Alsmeyer *et. al.,* 1974). Amino acid content of WF, MLP and CSP are shown in Table (3) along with the provisional pattern recommended by the FAO/WHO/ UNU (1985). Data presented in Table (3) clearly indicate that glutamic acid followed by alanine and aspartic acid are the most abundant amino acids of the MLP. Nevertheless, it is the essential amino acid content that count for the quality of a protein and its capacity to satisfy the needs for essential amino acids. In this concern, the tested proteins showed to have higher total amounts of essential amino acids than the FAO/WHO/UNU (1985) recommended pattern. WF showed to be relatively low in lysine content (2.15%). Most essential amino acids in Moringa leaf is higher than those found in soybean meal. Each amino acid has a specific function in the animal's body, methionine and cystine are powerful antioxidants. Lysine is an amino acid that helps in the absorption of calcium, vitamin C is essential nutritionally to make the collagen that helps the body form healthy bons, it also promotes bone healing. MLP showed to be relatively high in lysine content (5.71%), which indicates to be superior in this concern than cereals and oil seeds. The high concentrations of methionine, cystine, tryptophan and lysine in Moringa leaves make it a virtually ideal dietary supplement**.** A value of 5.71% was enough to satisfy the lysine requirement as recommended by the FAO/ WHO/ UNU (1985).

It is noteworthy that moringa contains argenine and histidine. Most important is that the protein is of high quality having significant quantities of all the essential amino acids, and moringa contains all of the essential amino acids and it is rich in essential amino acids. Thus, composition of the amino acids in the leaf protein is well balanced. Our results are in agreement with (Moyo et. al., 2011)

Data presented in Table (3) also indicate that glutamic acid was present in maximum concentration in the total amino acids content followed by aspartic acid and arginine, all essential amino acids, except S-containing types and tryptophan, are present in excessive amounts in chickpea. Chickpea considered as a good source of protein (24.5%), rich in lysine (6.49%). Due to its good balance of amino acid, chickpea seeds have been considered a suitable source of dietary proteins. Our results are in agreement with (Abou Arab et. al., 2010 and Alajaji and El-Adawy, 2006)

Table 3. Amino acid composition of wheat flour (72%) (WF), moringa leaf powder (MLP) and Chickpea seed powder (CSP). (g amino acid per 100g protein).

Amino acid	WF	MLP	CSP	FAO/WHO/ UNU,1985
1.Essential amino acids (EAA)				
Histidine	2.40	2.92	3.24	1.9
Isoleucine	4.2	4.15	4.65	2.8
Leucine	6.8	8.46	8.15	6.6
Lysine	2.15	5.71	6.89	5.8
Methionine	1.27	1.88	1.25	
Cystine	1.4	1.60	0.72	
Total sulfur amino acid	2.67	3.48	1.97	2.5
Phenylalanine	4.60	5.65	5.69	
Tyrosine	3.40	5.50	3.52	
Total aromatic amino acid	8.00	11.15	9.21	6.3
Threonine	2.90	4.71	3.72	3.4
Valine	4.58	5.50	5.09	3.5
Tryptophan*	1.09	1.68	1.18	1.1
Total EAA	34.79	47.76	44.1	33.9
2.Non- essential amino acids (N EAA)				
Alanine	4.03	10.08	4.42	
Arginine	7.34	6.96	9.05	
Aspartic acid	9.10	8.96	11.3	
Glutamic acid	24.09	10.98	17.8	
Glycine	4.35	5.56	4.08	
Proline	11.5	5.53	4.55	
Serine	4.80	4.17	4.7	
Total NEAA	65.21	52.24	55.9	

* Tryptophan was determined colorimetrically.

The chemical score:

The chemical score of WF, MLP and CSP are listed in Table (4), along with the amino acid score pattern for the FAO/WHO/UNU(1985).

Amino acid score is very important to evaluate the content of essential amino acids in foods and also to be enough the nutritional requirements of protein. WF is deficient in lysine and has low chemical score of being 37.06. Leaves of moringa are rich in protein (30.15%) and contain considerable amounts of essential amino acids (47.76%). Lysine has high chemical score of being 98.5. The values of amino acids profile reflect a desirable nutritional balance (Moyo et. al., 2011).

Table 4. Essential amino acids (mg/kg protein) of wheat flour (72%) (WF), moringa leaf powder (MLP) and Chickpea seed powder (CSP) proteins and their chemical scores in respect to FAO/WHO/UNU, 1985

(EAA)	FAO/WHO /UNU,1985	WF		MLP		CSP	
		mg/kg protein	CS	mg/kg protein	CS	mg/kg protein	CS
Histidine	19	24.0	126.3	29.2	153.7	32.4	170.53
Isoleucine	28	42.0	150	41.5	148.2	46.5	166.07
Leucine	66	68.0	103	84.6	128.18	81.5	123.49
Lysine	58	21.5	37.06*	57.1	98.5	68.9	118.79
Methionine		12.7		18.8		12.5	
Cystine		14.0		16.0		7.2	
Total sulfur amino acid	25	26.7	106.8	34.8	139.2	19.7	78.8*
Phenylalanine		46.0		56.5		56.9	
Tyrosine		34.0		55.0		35.2	
Total aromatic amino acid	63	80.0	126.9	111.5	176.98	92.1	146.19
Threonine	34	29.0	85.29	47.1	138.5	37.2	109.41
Valine	35	45.8	130.85	55.0	157.1	50.9	145.43
Tryptophan	11	10.9	99	16.8	152.7	11.8	107.27

* limiting amino acid
EAA = Essential amino acids CS = chemical score

Data from Table (4) show that CSP protein, like some other legumes, are common deficient in sulfur-containing amino acids, which are the limiting amino acids**.** These deficiencies need to be considered when CSP are used for nutrition purposes, however, lysine has high chemical score of being 118.79. Amino acid profile showed methionine and cystine as the limiting amino acids (78.8). Tryptophan was not observed to be the limiting amino acid in chickpea (107.27). Results are comparable to those of earlier workers (Abou Arab et. al., 2010). Amino acid deficiency can be met by employing the complementarity that exists between high sulphur amino acid cereals and legumes.

Protein efficiency ratio and biological value

The most widely used method for the measurement of protein quality is the protein efficiency ratio (PER) (Alsmeyer et. al., 1974). The values of PER and biological values (BV) of wheat flour (72%) (WF), moringa leaf powder (MLP) and chickpea seed powder (CSP) proteins are presented in Table (5). The PER and BV of WF, MLP and CSP proteins were found to be 2.26, 2.79, 2.86 and 73.69, 79.28, 80.02, respectively. MLP and CSP proteins showed to have PER value and BV higher than, that of casein, indicating that the MLP and CSP proteins are of high nutritional value. our results are in agreement with (Thurber and Fahey, 2009) who reported that, moringa leaves are high in protein quality, and its protein quality rivals that of milk.

The inclusion of pulses in cereal based food is known to increase the nutritive value by improving protein content, particularly the content of lysine (Abou Arab et. al., 2010). In general, it could be concluded that MLP and CSP are of high favorable amino acid balance, and considered a good source of lysine, and is worthy to be incorporated into cereal products such as noodles. Supplementation of wheat flour with MLP and CSP could produce noodles of high protein content and improve nutritional value of this noodles, particularly the content of lysine.

Table 5. Protein efficiency ratio (PER) and biological value (BV) of wheat flour (72%) (WF), moringa leaf powder (MLP) and Chickpea seed powder (CSP) proteins.

Sample	PER	BV
WF	2.26	73.69
MLP	2.79	79.28
CSP	2.86	80.02
Casein(reference)	2.50	76.23

Chemical composition of produced noodles

Data given in Table (6) represent values of protein, ether extract, ash, crude fiber and total carbohydrates on dry weight basis, for supplemented noodles with MLP (at 2.5%, 5% and 7.5% level) and CSP (at 7.5%, 10%, 12.5% and 15% level) as well as control (100% wheat flour) after cooking. Data showed that supplement of wheat flour with 2.5%, 5% and 7.5% of MLP as well as supplement of wheat flour with 7.5%, 10%, 12.5% and 15% of CSP showed increase in protein, fat, ash and crude fiber contents while carbohydrate contents were decreased for all supplementation levels. MLP-supplemented noodles showed increase in ash and crude fiber contents, with highest value for the 7.5% supplement relative to the control noodles, this might be due to the high ash and crude fiber contents of MLP than that of wheat flour. Also, protein increased of its blends compared to the control noodles at all levels of supplement. Data showed slightly increase in fat content. Changes in chemical composition was proportional to the level of supplement. These results are in agreement with those reported by (Dachana et. al., 2010)

Data in Table (6) also showed that, supplement of wheat flour with 7.5%, 10%, 12.5% and 15% of CSP showed increase in protein, fat, ash and crude fiber contents in noodles samples compared to the control noodles and the maximum content of protein in samples present in noodles contained chickpea was 12.35% at replacement level 15%. On the other hand, carbohydrate contents were decreased for all supplementation levels, and the changes, positively or negatively, were proportional with the level of addition, our results are in agreement with those reported by (Abou Arab et. al., 2010)

Table (6) showed also the composition of elements: Calcium (Ca), iron (Fe), zinc (Zn) and magnesium (Mg) for supplemented noodles with MLP (at 2.5%, 5% and 7.5% levels), CSP (at 7.5%, 10%, 12.5% and 15% levels) and control (100% WF) after cooking, on dry weight basis. Data in Table (6) showed that supplement of wheat flour with MLP and CSP showed increase in Ca, Fe, Zn and Mg contents at all supplementation levels, with highest value for MLP at 7.5% level and for CSP at 15% level supplement relative to the control noodles.This might be due to the high mineral contents of MLP and CSP than that of wheat flour. These results are in agreement with those reported by (Abou Arab et. al., 2010 and Dachana et. al., 2010)

From the previous results it should be conclude that, nutrients such as vegetable protein from MLP and CSP have high nutritional value and should be included as part of an intervention diet.

Table 6. Chemical composition and minerals contents of the supplemented noodles with moringa leaf powder (MLP) and chickpea seed powder (CSP) at different levels (on dry weight basis).

	Control	MLP 2.5%	MLP 5%	MLP 7.5%	CSP 7.5%	CSP 10%	CSP 12.5%	CSP 15%
Crude protein	10.14	10.71	11.2	11.7	11.29	11.65	12.0	12.35
Ether extract	12.00	12.11	12.21	12.32	12.36	12.48	12.61	12.73
Ash	1.00	1.31	1.61	1.92	1.24	1.32	1.40	1.48
Crude fiber	1.15	1.60	2.01	2.40	1.38	1.49	1.58	1.69
Total carbohydrates	75.71	74.27	72.97	71.66	73.73	73.06	72.41	71.75
Minerals (mg/100g)								
Ca	53.0	140.54	228.08	315.66	64.5	68.19	72.05	75.79
Fe	1.35	2.66	3.95	5.26	1.88	2.04	2.22	2.39
Zn	0.80	0.86	0.92	0.98	1.06	1.14	1.23	1.32
Mg	0.34	14.46	28.58	42.69	13.44	17.8	22.18	26.56

Cooking quality of produced noodles

Data given in Table (7) represent values of increasing weight, weight gain percentage and uncooked to cooked weight (g) ratio after cooking the supplemented noodles with MLP and CSP at different levels. Table (7) showed increase in cooked weight and weight gain percentage for all supplementation levels relative to control noodles, while showed decrease in uncooked to cooked weight ratio for all supplementation levels relative to control noodles. Changes in cooked weight, weight gain percentage and uncooked to cooked weight ratio was proportional to the level of supplement. These results indicated that the control noodles had the lowest cooked weight and weight gain percentage value comparing with the other noodles. The overall network that holds noodle structure may consist primarily of protein and starch matrices. These matrices gradually disintegrate during cooking that results in the absorption of water followed by swelling up of starch granules and increasing weight**.** A number of factors such as hydrophilic-hydrophobic balance of amino acids molecular size and shape influence the water absorption of flours. An oil absorption capacity is due to binding of fat by non-polar side chains of proteins. These results might be due to that moringa leaf powder and chickpea seed powder have high fiber and protein contents, water holding capacity and oil holding capacity comparing with wheat flour, which affect of water and oil adsorption and, consequently, increasing weight. Our results are in agreement with (Dachana et. al., 2010) who reported that, incorporation of increasing amount of moringa increased farinograph water absorption. Flours with high water absorption have more hydrophilic constituents, such as polysaccharides. Therefore, the higher water absorption capacity of CSP than WF could be attributed to the presence of greater amounts of hydrophilic constituents in them. The inherent proteins in CSP may also have played some role in the higher water absorption capacity. On the other hand, oil absorption capacity of CSP was high because it had more available non-polar side chains in its protein molecules (Abou Arab et. al., 2010 and Alajaji and El-Adawy, 2006)

Table 7. Increasing weight and uncooked to cooked weight (g) ratio after cooking the supplemented noodles with moringa leaf powder (MLP) and chickpea seed powder (CSP) at different levels.

	Sample weight (g)	Weight ratio after 3 min		
		Weight (g)	Percentage	Ratio
Control	10	22.25	122.5%	0.449
MLP 2.5%	10	24.35	143.46%	0.411
MLP 5.0%	10	24.72	147.17%	0.405
MLP 7.5%	10	25.39	153.88%	0.394
CSP 7.50%	10	22.65	126.5%	0.442
CSP 10.0%	10	25.16	151.6%	0.398
CSP 12.5%	10	27.82	178.2%	0.360
CSP 15.0%	10	30.49	204.9%	0.328

Control=100% Wheat flour

Cooking loss is one of the most important factors that influence the cooking quality of the noodles, high cooking loss is undersirable, since it represents high solubility of starch, resulting turbid cooking water, low cooking tolerance and sticky mouthfeel. Table (8) illustrated the changes in the cooking loss as a function of supplemented noodles with MLP and CSP at different levels. Data in Table (8) showed that supplement of wheat flour with MLP and CSP showed decrease in cooking loss relative to the control noodles at all supplementation levels. The control noodles had the highest cooking loss value comparing with the other noodles. These results might be due to a number of factors such as starch granules, solubility of starch, high fiber and protein contents of MLP and CSP. A possible reason for these results is that gelatinized starch can prevent leaching of soluble material into water.

Table 8. Cooking loss of the supplemented noodles with moringa leaf powder (MLP) and chickpea seed powder (CSP) at different levels (on dry weight basis).

	Sample weight (g)	Cooking loss% after 3 min
Control	10	8.23%
MLP 2.5%	10	7.67%
MLP 5.0%	10	7.35%
MLP 7.5%	10	7.15%
CSP 7.50%	10	6.14%
CSP 10.0%	10	5.95%
CSP 12.5%	10	5.35%
CSP 15.0%	10	5.02%

The organoleptic characteristics of produced noodles

The organoleptic characteristics of noodles prepared from wheat flour as control and of the noodles prepared from wheat flour containing different levels of moringa leaf powder (MLP) and chickpea seed powder (CSP) are given in Table (9). From data presented in Table (9) it could be observed that supplementation of noodles with MLP led to significant increase the color at 5% and 7.5% supplementation levels relative to control noodles, while texture significant increase at all supplementation levels relative to control noodles. The taste significant increase at 5% substitution with MLP while no significant difference at 2.5% and 7.5% supplementation levels relative to control. The noodles were accepted until supplementation level 7.5% MLP to wheat flour, while they were well accepted at supplementation level 5% MLP. MLP improve the overall appearance of noodles, and also contribute to consumers' health and well-being (Thurber and Fahey, 2009, Dachana et. al., 2010 and Das et. al., 2012)

Supplementation of noodles with CSP led to significant increase the taste and texture at all supplementation levels relative to control noodles, while color significant increase at 10%, 12.5% and 15% supplementation levels relative to control noodles. The noodles were accepted until supplementation level 15% CSP to wheat flour, while they were well accepted at supplementation level 12.5% CSP. This would definitely encourage the utilization of MLP and CSP to be incorporated in noodles to improve its color and nutritional value and also to provide decorated food (green-colored noodles with MLP) to the consumer. These results are in agreement with that found by (Johnson *et. al.,* 2005).

Table 9. Organoleptic characteristic of the supplemented noodles with moringa leaf powder (MLP) and chickpea seed powder (CSP) at different levels.

	Color (10)	Taste (10)	Texture (10)	Overall Acceptability
Control	8.5^{a}	8.5^{a}	8.0^{a}	25^{a}
MLP 2.5%	8.5^{a}	8.5^{a}	8.5^{b}	25.5^{b}
MLP 5%	8.9^{d}	9.0^{d}	9.0^{c}	26.9^{cd}
MLP 7.5%	9.2^{d}	8.5^{a}	9.0^{c}	26.7^{c}
CSP 7.5%	8.3^{c}	8.7^{b}	8.5^{b}	25.5^{b}
CSP 10%	8.8^{b}	9.0^{d}	9.0^{c}	26.8^{cd}
CSP 12.5%	9.0^{d}	9.2^{d}	9.3^{cd}	27.5^{d}
CSP 15%	8.9^{d}	9.1^{d}	9.25^{cd}	27.25^{d}

Values followed by the same letter in same column are not significantly different at $p \leq 0.05$

Control= 100% Wheat flour

CONCLUSION

Reviewing above mentioned results obtained in this study, it could be concluded that MLP and CSP are good sources of protein, crude fiber, and minerals (calcium, iron, zinc, and magnesium) which are vital for human nutrition and maintains a good health, beside, MLP and CSP are of high favorable amino acid balance, and considered a good source of lysine, and is worthy to be incorporated into cereal products such as noodles. Supplementation of wheat flour with MLP and CSP produce noodles of high protein content and improve nutritional value of this noodles, particularly the content of lysine. Noodles were well accepted until supplementation levels 5% MLP and 12.5% CSP to wheat flour.

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تجهيز و تقييم نودلز ملونة و مدعمة بمصادر طبيعية عالية محتوى الليسين

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معهد بحوث وتكنولوجيا الأغذية – مركز البحوث الزراعية – جيزة

مطحون ورق المورينجا و بذور الحمص مصادر جيدة للبروتين (٣٠،١٥٪ و ٢٤،٥٪ على التوالى) ايضا ورق المورينجا يحتوى على نسبة عالية من الالياف (١٦،٢٪) و الرماد (١٢،٨٥٪) والتى تعتبر حيوية و هامة فى تغذية الانسان و الحفاظ على صحته. دقيق القمح يحتوى على بروتين و رماد و الياف خام (١٠،١٨٪ و٠،٦٣٪ و٠،٧٥٪ على التوالى) اقل منها فى مطحون ورق المورينجا و بذور الحمص. اوضحت النتائج ان ورق المورينجا مصدرا غنيا بالكالسيوم والحديد و الزنك و الماغنسيوم. ايضا الحمص مصدر غنى بالزنك و الماغنسيوم كما يحتوى كميات معقولة من الحديد. بينما اظهر دقيق القمح محتوى اقل من المعادن مقارنة بكل من المورينجا و الحمص. بجانب محتوى المورينجا و الحمص العالى من الاحماض الامينية المتوازنة و يعتبروا مصادر جيدة للحمض الامينى ليسين (٥،٧١ و ٦،٨٩ جم/١٠٠جم بروتين على التوالى). و قد اظهرت بروتينات المورينجا والحمص محتوى عالى من الاحماض الامينية الاساسية و ذلك مقارنة مع FAO/WHO/UNU (1985). ادى تدعيم دقيق القمح بمطحون كل من اوراق المورينجا (بنسبة ٢،٥% و ٥% و ٧،٥%) و بذور الحمص (بنسبة ٧،٥% و ١٠% و ١٢،٥% و ١٥%) لانتاج نودلز عالية البروتين وتحسين لونها و قيمتها الغذائية خاصة محتواها من الحمض الامينى ليسين و تقديم اغذية ملونة (لون اخضر مع المورينجا) ترضى ذوق المستهلك خاصة الاطفال. و كانت نسبة التدعيم مقبولة بدرجة جيدة حتى ٥٪ بالنسبة للمورينجا و حتى ١٢،٥٪ بالنسبة للحمص.