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NUTRITIONAL EVALUATION OF SPAGHETTI REPLACED BY SOME RAW LEGUME FLOURS AND TREATED WITH DIFFERENT TECHNOLOGICAL METHODS.

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ABSTRACT

Wheat flour (72% extraction) was replaced with different forms of faba bean and lentil flours (raw, germinated for 3 days and blanched at 100°C for 50 min. and 20 min for faba bean and lentil respectively) to produce high protein spaghetti. The rate of replacement was 10, 15, 20, 25 and 30%. Chemical composition, functional properties for both legume flours, amino acid composition, chemical score for raw materials were measured. Also, chemical composition, cooking quality, colour attributes and sensory evaluation of produced spaghetti were determined. The results showed thet both germinated faba bean and lentil had high protein content, water and oil absorption, foam capacity and solubility values. Also, all processed legume flours were rich in most essential and non-essential amino acids and had high protein, ash and fiber contents. All levels of replacement with different both type of legume flours increased all the components of chemical composition, mineral content and decreased the change in cooked weight and volume and increased the change in cooked loss in produced spaghetti compared with control. Samples contained all forms of faba bean flour had the best values of lightness (L), redness (a) and acceptable colour at all levels of replacement. Sensory evaluation showed that all spaghetti samples replaced with faba bean flours had high score of sensory characteristics than those produced from lentil flours at all levels of replacement. Acceptable spaghetti samples could be produced by using raw and blanched faba bean flours until 20%, germinated faba bean flour reached to 25% and different forms of lentil flour up to 15% replacement level of wheat flour.
Keywords: Spaghetti, faba bean and lentil flours and cooking quality.

INTRODUCTION

Pasta has long been a favorite of Chinese and Mediterranean civilization and is currently consumed and appreciated world wide. Products of pasta form a class of foods which are economically, simple to prepare, has excellent storage properties and can be served in many different ways, (Breen *et al.*, 1977). Durum semolina is generally recognized as the best raw material for pasta production. In some countries like Egypt because of high semolina prices, pasta can be manufactured from wheat flour (72%) as a popular product.

Wheat flour like other cereals is generally deficient in lysine and threonine. Legumes had a high protein content and it was twice greater than cereals ranging from 17% to 25% on a dry weight basis (Uebersax *et al.*, 1989).

Therefore, by the selective addition of legumes protein to pasta, nutritional value can be improved and the protein content increased (Morad *et al.*, 1980, Bahnassey and Khan 1986, Bahnassey *et al.*, 1986 and Adams, 1987). Faba bean (Vicia faba) is a high protein crop grown in Egypt contains about 20-30% and is a superior source of lysine. It is one of the protein most common legumes consumed in the stewed form called Medammis and also as the germinated and blanched form called Nabet (El-shimi, 1980). Also, lentil (Lens culinaris) is one of such important legumes which is usually highly consumed in winter. Protein content of lentil may vary from 20% to 35% of the dry wheight seed. (Bhatty 1988, 1995 and Savage 1988).

Many researchers have studied the effect of germination and heat processing on the functional properties of some legumes (Hus *et al.* 1980, 1982, Sosulski and Mccurdy 1987, Abbey and Ibeh 1987 and Gaur *et al.* 1992). *Abu-Arab (1991) reported that, germination process of chickpea,* lentil and faba bean seeds for 2 and 4 days increased the total protein and lipids and decreased the total carbohydrates of legume flours as sprouting period advanced. Flours from germinated seeds for 2 days had the highest nitrogen solubility index. While germination for 4 days improved emulsion capacity, oil and water absorption. Carbonaro *et al.* (1993 and 1997) stated that cooking of faba bean, lentil, chickpea and dry bean by autoclave for 20 min at 120°C caused a marked reduction in protein solubility in the pH range (1-13). Prinyawiwatkul *et al.* (1997) found that, heat treatment of cowpea seeds (boiling for 45 min.) sharply reduced solubility, increased water and oil retention and impaired emulsifying properties of flour.

Supplementation of pasta with different legumes flours has been investigated. Duarte *et al.* (1996) produced spaghetti containing lupin flour at levels 5, 15, 25 and 30%, the majorty of the samples *exhibited acceptable* cooked weights of about three times the dry weight. The cooking loss ranged from 7.20 to 8.00% significantly higher than that of the control but still at acceptable levels.

Rasmay et al. (2000) studied the nutritional quality of macaroni, wheat flour (72% extraction) supplemented with 5, 10 and 15% of raw and germinated legumes (chickpea, sweet lupin and mung bean) meals or their protein concentrates was used to produce high protein macaroni. Legume products improved protein, ash and crude fiber contents and cooking quality of supplemented macaroni compared with control. Such improvements were more pronounced for germinated legume products.

The present work was carried out to improve the nutritive value of spaghetti produced from wheat flour by replacement with different forms of faba bean and lentil flours at levels 10, 15, 20, 25 and 30% and evaluate the quality and sensory characteristics of produced spaghetti.

MATERIALS AND METHODS

Materials:

Hard wheat flour (72% extraction) was purchased from the North Cairo Mills Company, Egypt. Faba bean (Vicia faba) variety Giza 2 and Lentil *(Lens culinaris) variety Giza 9 were obtained from the Field Crops Research* Institute, Agricultural Research Centre, Ministry of Agriculture, Egypt.

Preparation of Samples:

All samples were manually sorted to remove split, wrinkled and moldy legumes and foreigen materials. Samples were divided into three parts. The first part was raw seeds. The second part was germinated and the third part was blanched seeds.

Germination:

Faba bean and lentil seeds were germinated according to the method of Khalil and Mansour (1995). Seeds were soaked in distilled water for 12h at room temperature. The soaked seeds were drained and germinated on thick layers of cotton cloth in petri dishes at room temperature for 3 days. the seeds were rinsed with distilled water, mashed and dried at 50°C overnight in an electric oven.

Blanching:

Seeds were blanched by the method of Abu El-Maatti (1997). Samples were soaked in distilled water (1:3, w/v) at room temperature for 10h. The soaked samples were drained before sampling. The rehydrated samples were immersed in boiling distilled water (100°C) in a container for 20 min and 50 min for lentil and faba bean respectively. Immediately after blanching, they were cooled under running water to room temperature, drained before sampling and dried at 50°C overnight in an electric oven.

Raw and processed samples of faba bean and lentil were ground in an electric grinder to pass through a 60 mesh sieves, then packed in polyethylene sacs and kept at – 20°C until analysis.

Analytical Methods:

Moisture, protein, fat, ash and fiber were determined according to the methods described by the A.O.A.C. (1995). Total carbohydrates were calculated by difference.

Total contents of calcium, magnesium, sodium, potassium, cupper, zinc and iron were determined according to the A.O.A.C. methods (1995).

Amino acid score (AAS) was calculated as the following equation:-

$$AAS\% = \frac{\text{g. amino acid of sample}}{\text{g. same amino acid of FAO/WHO reference protein 1985}} \times 100$$

Amino acid contents were determined at the central food and feed Laboratory of the Egyptian Agriculture Organization, using Amino Acid Analyzer (Beckman system 7300 and Data system 7000). The samples were prepared as described by Moore *et al.* (1958); and Winder and Eggum (1966).

Functional properties :

Water absorption

This was measured by the method of Sosulski (1962) at room temperature. The values were expressed as g of water absorbed by 100g of flour.

Oil absorption

This was determined by the method of Sosulski *et al.* (1976) at room temperature, using refined corn oil. The oil absorption capacity was expressed as g of oil absorbed by 100g of flour.

Protein solubility:

Protein solubility was determined by the method of King *et al.* (1985), with minor modification. Suspensions containing 1% protein (w/v) were prepared at pH values ranging from 1 to 10 using HCl or NaoH. The suspensions were magnetically stirred for 15 min, then centrifuged for 10 min at 4000 rpm. Protein in the supernatant was estimated by the Kjeldahl method.

Oil emulsification:

Emulsification capacity was determined by the procedure of Beuchat (1977) at room temperature. One g sample was blended in a Braun mixer with 50 ml distilled water for 30 sec at maximum speed. Refined corn oil was added continuously from a burette and blending continued until the emulsion breakpoint was reached. The amount of oil added up to this was interpreted as the emulsifying capacity of the sample.

Foaming properties:

These were determined as described by Huffman *et al.*, (1975) at room temperature, using 1% protein solution. Foaming capacity was expressed as the percentage increase in the volume after 30 sec., and foam stability was expressed as the foam volume measured after 10, 30, 60, 90 and 120 min.

Processing of spaghetti samples:

The spaghetti samples were prepared in the Food Technology Department NRC, cairo, Egypt, by using pasta matic 1000 simac Machine corporation, Millano, Italy. For preparation of replacement spaghetti, 10, 15, 20, 25 and 30 g of raw, germinated and blanched faba bean and lentil flours were individually added to the basal spaghetti recipe, substituting for an equivalent amount of wheat flour. The mixing time was 4-6 min. at 30 rpm under vacuum value of 35 cm Hg. Spaghetti was hydrated under atmospheric air for 15 min., then dried in a cabinet dryer at 40°C for 14 hours. The samples were cooled enough at room temperature, then packed in polyethylene pouches and stored at room temperature until analysis.

Cooking quality of spaghetti weight increase, volume increase, and cooking loss were evaluated according to the methods described by AACC (1983).

Spaghetti Color:

Color was measured by using a spectro-colorimeter (tristimulus color machine) with CIE lab color scale (Hunter, Lab Scan XE, Reston VA.) calibrated with a white standard tile of Hunter Lab color standard (LX NO.

16379): X = 77.26, Y= 81.94 and Z= 88.14 (L^*= 92.43, a^* = -0.86, b^*= -0.16). Color difference (ΔE) was calculated from a, b and L parameters, using Hunter-Scotfield's equation (Hunter, 1975).

$$\Delta E = (\Delta a^2 + \Delta b^2 + \Delta L^2)^{1/2}$$

Where a= $a - a_o$, b= $b - b_o$ and L= $L - L_o$. Subscript "O" indicates color of control. Hue angle (t_g^{-1} b/a) and saturation index [$\sqrt{a^2+b^2}$] were also calculated.

Sensory evaluation and statistical analysis :

Appearance, color, taste, tenderness and stickiness of the spaghetti were evaluated organoleptically as described by Hallabo *et al.* (1985). The results were evaluated by analysis of variance and least significant difference (LSD) as reported by McClave and Benson (1991).

RESULTS AND DISCUSSION

Chemical composition of wheat flour, raw and processed legume flours

Data presented in Table (1) show the chemical composition of wheat flour and different forms of faba bean and lentil flours. Raw faba bean and lentil flours contained high values of all components of chemical composition except fat and total carbohydrates as compared with wheat flour. The protein content of all different forms of legume flours was higher with more two fold than that found in wheat flour. Germination increased protein, fat, ash and fiber contents of legume flours. This increase is mainly due to the consumption of the other legumes components and degradation of the high molecules of the protein to simple peptides during germination process. The decrease in total carbohydrate content could be attributed to their consumption as a source of energy for the germination process. These results are in good agreement with those reported by Lee and Karunanithy (1990), Abu-Arab (1991) ,Kavas and Nehir (1992), and Khalil and Mansour (1995).

Table (1): Chemical composition of wheat flour, different forms of faba bean and lentil flours (on dry weight basis).

Components %	Wheat flour	Faba bean flour			Lentil flour		
		Raw	Germinated	Blanched	Raw	Germinated	Blanched
Protein	13.61	30.76	32.19	29.14	29.60	32.96	27.86
Fat	1.83	1.52	1.85	1.30	1.47	2.89	1.23
Ash	1.76	3.80	4.06	3.42	2.83	3.10	2.37
Fiber	2.60	7.74	8.92	8.01	3.54	4.20	4.14
Total carbohydrates	80.20	56.18	52.98	58.13	62.56	56.85	64.40
Element (mg/100g)							
Calcium	42.91	214.30	208.20	200.51	85.40	78.71	62.85
Magnesium	89.87	275.12	228.14	259.49	172.83	148.29	160.97
Sodium	1.42	289.15	278.36	281.65	153.78	117.46	138.89
Potassium	102.50	736.34	310.20	460.91	1318.25	1023.35	1175.68
Cupper	0.38	3.21	2.95	3.07	1.14	0.92	1.09
Zinc	2.19	10.96	10.67	10.14	3.56	3.34	3.14
Iron	2.70	6.43	6.31	6.10	7.73	7.60	7.26

The results in the same table showed that all forms of legume flours had higher values of all elements than those occurred in wheat flour. The reduction in mineral content was greater in germinated flours (except calcium, zinc and iron) then blanched flours. The content of minerals was increased in different forms of faba bean except potassium and iron compared with those found in lentil flours (raw, germinated and blanched). These decreases might be attributed to the leaching of such minerals into soaking water. These results are in reasonably good agreement with those reported by Lee and Karunanithy (1990) and Khalil and Mansour (1995). They stated that the loss of divalent metals (Ca, Fe and Zn) was low during germination of beans and due to their binding to protein and, also, the formation of a phytate-cation-protein complex. Similar findings were observed by El-shimi (1980) who found that sodium and potassium levels in faba bean were decreased as germination proceeded. In the same respect, Donangelo *et al.* (1995) reported that germination for 2 days caused a decrease in Fe and Cu contents of lupin, soybean and black bean seeds and this result was probably related to losses in the washing and soaking of the seeds prior to germination.

Amino acids composition:

Amino acids composition of wheat flour and different forms of faba bean and lentil flours are presented in Table (2). Values of total determined amino acids were higher in all raw and processed legume flours than that of wheat flour. The same result was observed in values of total essential amino acids. All forms of legume flours had more contents of leucine, lysine and threonine than that of wheat flour. Cystine and methionine were lowered in different legume flours. Little variation in phenylalanine and tyrosine contents was found between legume flours and wheat flour. Leucine was the most predominate essential amino acid in different legume flours and wheat flour. Among non-essential amino acids, glutamic acid and proline were notably high in wheat flour. Glutamic acid was the most predominate non-essential amino acids in all samples.

These results are in agreement with those obtained by Carbonaro *et al.* (1997). Who reported that, lysine and leucine together were the major essential amino acid in raw faba bean and lentil flours. Also, our results confirmed those obtained by Hsu *et al.* (1980) and Khalil and Mansour (1995). They reported that germination had little change of essential amino acid content in dry pea, lentil and faba bean flours. Results of blanched flours are in agreement with those found by Zinea (1989) who reported that cooking faba bean with low heat for a short time resulted in significant declines in most essential amino acids. In the same respect, Clemente *et al.* (1998) observed that heat treatment produced a decrease of methionine, cystire, lysine, arginine, tyrosine and leucine contents in cooked chickpea seeds at 120°C under pressure for 50 min.

Table (2): Amino acids profiles of wheat flour, raw, germinated and blanched of faba bean and lentil flours(g/100g protein).

Amino acids (g/100g protein). Essential amino acids:	Wheat flour	Faba bean flour			Lentil flour		
		Raw	Germinated	Blanched	Raw	Germinated	Blanched
Leucine	6.96	7.71	8.07	7.45	7.58	7.84	7.21
Isoleucine	4.25	4.27	3.90	4.16	4.40	4.71	4.26
Lysine	2.14	6.77	7.19	6.62	6.79	6.96	6.43
Cystine	1.33	1.12	1.25	1.03	0.81	0.94	0.76
Methionine	2.00	0.70	0.84	0.61	1.14	1.23	1.08
Phenylalanine	4.48	4.42	4.36	4.29	4.34	4.47	4.21
Tyrosine	3.50	3.40	3.30	3.26	3.41	3.63	3.28
Threonine	2.60	4.15	4.34	3.95	3.78	4.18	3.53
Valine	4.94	5.20	5.44	4.98	4.92	5.22	5.00
Non-essential amino acids:							
Alanine	3.94	4.24	4.45	4.02	4.30	4.59	4.11
Arginine	3.61	7.46	7.32	7.14	8.76	9.28	8.34
Aspartic acid	4.64	11.80	12.35	11.56	11.62	11.95	11.28
Glutamic acid	*26.59*	*18.08*	*18.92*	*17.67*	*16.90*	17.32	16.40
Glycine	3.36	4.37	4.24	4.10	3.84	4.08	3.61
Histidine	2.45	2.68	2.80	2.54	2.58	2.87	2.43
Proline	8.11	3.45	3.63	3.37	4.39	4.61	4.15
Serine	3.85	4.28	4.49	3.98	4.97	5.14	4.68
Total essential amino acids	*32.20*	*37.74*	*38.69*	36.35	37.17	39.18	35.76
Total determined amino acids	88.75	94.10	96.89	90.73	94.53	99.02	90.76

Amino acid scores :

The amino acid scores for essential amino acids in different samples are given in Table (3). The results in this table, indicated that methionine + cystine, threonine and valine were found to be the first, second and third limiting amino acids in the raw and blanched flours of faba bean and lentil *respectively. Methionine + cystine and threonine were the first* and third limiting amino acids in germinated faba bean and lentil flours respectively while, isoleucine and valine were the second limiting amino acids in the same samples respectively. wheat flour had lysine, threonine and methionine + cystine as the first, second and third limiting amino acids respectively. These results *are in agreement with those reported by Kavas and Nehir (1992) and* Khalil and Mansour (1995). They reported that sulphur-containing amino acids and valine were the first and second limiting amino acids respectively in raw, cooked and germinated faba bean and lentil flours.

Functional properties :

The *functional* properties of raw, *germinated and blanched legume* flours are shown in Table (4). Different forms of lentil flour had higher values of water absorption, oil emulsifying capacity and foaming stability than that of faba bean flours.

Table (3): Amino aid scores of wheat flour, raw, germinated and blanched of faba bean and lentil flours.

Essential amino acids (g/100g protein)	Faba bean flour			Lentil flour			Wheat flour	Ref. Pattern (FAO/WHO 1985)	Amino acid scores (%)						
	Raw	Germinated	Blanched	Raw	Germinated	Blanched			Raw faba bean flour	Germinated faba bean flour	Blanched faba bean flour	Raw lentil flour	Germinated lentil flour	Blanched lentil flour	Wheat flour
Leucine	7.71	8.07	7.45	7.58	7.84	7.21	6.96	7.00	110.14	115.29	106.43	108.29	112.00	103.00	99.43
Isoleucine	4.27	3.90	4.36	4.40	4.71	4.26	4.25	4.00	106.75	97.50	109.00	110.00	117.75	106.50	106.25
Lysine	6.77	7.19	6.62	6.79	6.96	6.43	2.14	5.50	123.09	130.73	120.36	123.45	126.55	116.91	38.91
Methionine + Cystine	1.82	2.09	1.64	1.95	2.17	1.84	3.33	3.50	52.00	59.71	46.86	55.71	62.00	52.57	95.14
Phenylalanine + Tyrosine	7.82	7.66	7.55	7.75	8.10	7.49	7.98	6.80	115.00	112.65	111.03	113.97	119.12	110.15	117.35
Threonine	4.15	4.34	3.95	3.78	4.18	3.53	2.60	4.00	103.75	108.50	98.75	94.50	104.50	88.25	65.00
Valine	5.20	5.44	4.98	4.92	5.22	5.00	4.94	5.00	104.00	108.80	99.60	98.40	104.40	94.80	98.80

Table (4): Functional properties of different forms of faba bean and lentil flours.

Samples	Water absorption (%) g. water/100g. sample	Oil absorption (%) ml oil/100g. sample	oil emulsifying capacity (EC) ml oil/g sample	Foaming capacity (FC) ml/g. sample	Foaming stability (FS) after time (min) ml / g. sample				
					10	30	60	90	120
Raw faba bean flour	85.27	70.49	149	260	68	49	32	22	17
Germinated faba bean flour	97.78	86.35	128	376	63	38	27	19	15
Blanched faba bean flour	90.09	74.56	121.80	245	61	34	22	16	12
Raw lentil flour	87.50	62.75	168.20	247	94	89	82	73	67
Germinated lentil flour	154.14	84.20	155.60	.305	84	55	48	43	38
Blanched lentil flour	93.97	68.39	146	230	79	50	42	35	29

Oil absorption and foaming capacity values were higher in faba bean flours compared with those of lentil flours. Both germinated faba bean and lentil flours had the highest values of water absorption, oil absorption and foaming capacity. Values of oil emulsifying capacity were decreased in germinated faba bean and lentil flours compared with raw samples. Germination also decreased the foaming stability values of faba bean and lentil flours. Values of foaming stability were decreased as the period of time increased, highest values were found in raw lentil flour among the samples investigated. These results coulde attributed to protein modification during germination as a result of absorption of water which activate protease enzymes and hydrolysis of peptide bonds to release more charged anionic and cationic (polar) groups caused the last effects. These results are in agreement with those reported by Morad *et al* (1980), Hsu *et al*. (1982) and Abu-Arab (1991). They reported that, germination tend to increase the values of water, oil absorption and foaming capacity and decrease the values of oil emulsifying capacity and foaming stability of yellow pea, chick pea, lentil and faba bean flours. Generally, blanching had a reduction effect on all components values of functional properties for both faba bean and lentil flours except water and oil absorption which was higher than those of raw flours. This increase could be due to the dissociation of the proteins that might occur on heating and also to denaturation which would unmask the non-polar residues from the interior of the protein molecule. Similar findings were found by Abbey and Ibeh (1987). They reported that heat processed brown bean flour had significantly higher water absorption capacity 3.4 g/g flour than the raw flour, 2.7 g/g and also significantly increased the fat absorption capacity from 2.9 g/g flour to 3.4 g/g four. The obtained results confirmed these obtained by Narayana and Rao (1982), Okezie and Beils (1988) and Elizalde *et al*. (1988).

Solubility curves of different forms of faba bean and lentil flours are given in Fig (1). Germinated lentil and faba bean flours had higher values of protein solubility than the other samples. Lowest values of protein solubility was found at pH 4.5 which represented the isoelectric point whereas on either side,of this pH (at the acidic and alkaline pHs) solubility was increased. These results are in agreement with those obtained by Abu-Arab (1991) who reported that germinated lentil for 2days had the highest protein solubility at pH values ranged between 2-8 than that found in raw and germinated faba bean and chickpea flours. Similar findings were noticed in protein isolates from germinated faba bean, lentil and yellow pea flours for 4 days (Hsu *et al*. 1982). On the other hand, blanched flours had minimum values of protein solubility among all the studied samples. That is may be due to heating caused part of the proteins to be rendered insoluble which was attributed to protein denaturation and has traditionally been associated with loss of solubility as reported by Carbonaro *et al*. (1993) and (1997). Who found that a marked reduction in protein solubility was observed after cooking by autoclave for 20min at 120°C of faba bean, lentil, chickpea and dry bean in the pH range (1-13).

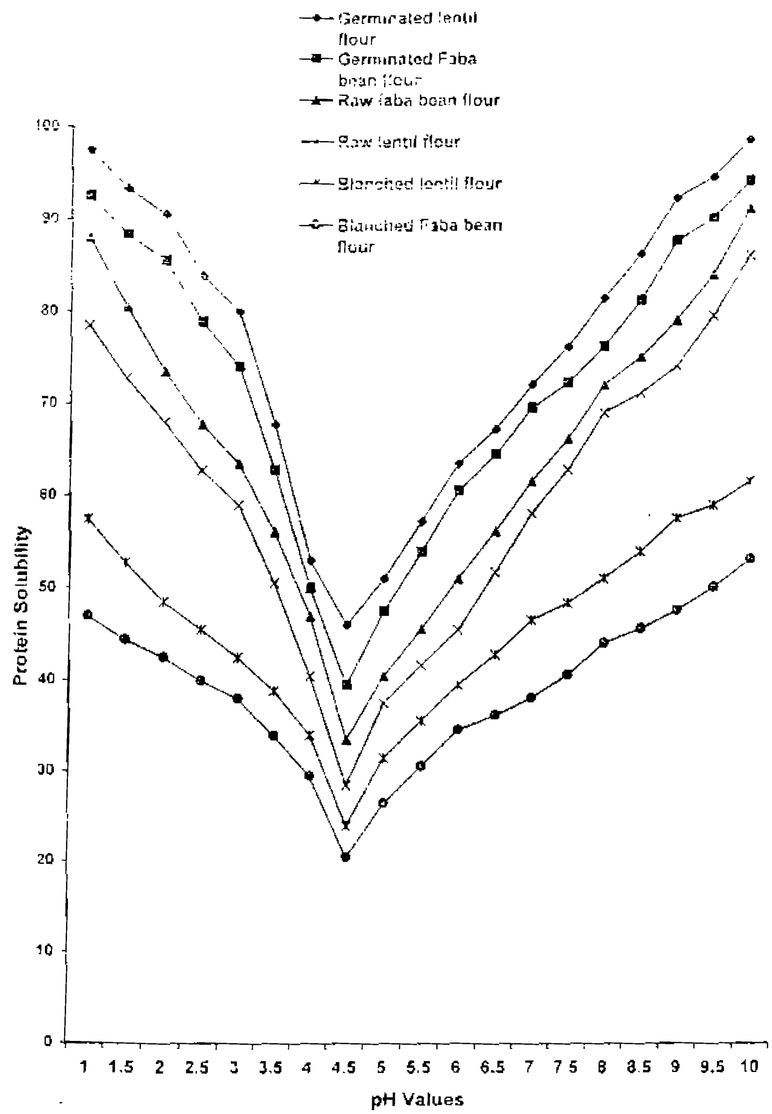

Fig.1 : Protein Solubility curves of different forms of faba bean and lentil flours.

Heating is responsible for protein denaturation, eventually followed by aggregation of the unfolded molecules, which results in loss of solubility. Kinsella *et al.* (1985) stated that, thermal denaturation involves an initial stepwise dissociation of subunits and a subsequent reassociation of only partially unfolded molecules with formation of either soluble or insoluble complex.

In this respect, Abbey and Ibeh (1987) reported that protein solubility decreased in heat processed brown bean flour (autoclaved for 15 min at 121°C) at evey pH studied (2-12) and at pH 2, protein solubility of 64 g/ml was observed compared to 218 g/ml for raw brown bean flour. Such findings also obtained by Gaur *et al.* (1992). Who reported that protein solubility of autoclaved faba bean flour was lower than that of raw flour in the pH rang (1-13).

Chemical composition of spaghetti :

Chemical composition of spaghetti replaced with different forms of faba bean and lentil flours are presented in tables (5 and 6). The results indicated that, spaghetti samples replaced with different legume flours had high protein, fat, ash and fiber contents as compared with control. The rate of increase in the last constituents was increased with increasing levels of replacement except fat content. These results could be explained by the fact that raw and processed legume flours contain higher levels of these constituents than that of the wheat flour. High values of protein and fat contents were noticed in spaghetti samples replaced with germinated lentil at all levels and ranged between 15.50 – 19.36% and 1.92-2.13% respectively. At all levels of replacement, spaghetti samples replaced with germinated faba bean flour had higher values of ash and fiber than that of the studied samples, ranged between 1.97-2.44% and 3.21-4.47% respectively. Lower values of total carbohydrates were occurred in all replacement levels of spaghetti samples than those of wheat flour. Such findings obtained by Rasmay *et al.* (2000). Who reported that supplementation of macaroni made from wheat flour (72% extraction) with 5, 10 or 15% of ungerminated or germinated chickpea, sweet lupin and mung bean meals tend to increase protein, ash and crude fiber contents of supplemented macaroni compared with control, such increments were more pronounced for germinated legume products. Moreover, protein, ash and fiber contents of the fortified spaghetti with 10 and 15% of nonroasted or roasted navy, pinto beans and lentil flours exceeded the levels for the control spaghetti (Bahnassey *et al.* 1986). In this respect, Taha *et al.* (1992b) reported that incorporation of soy flour or defatted soy flour at level 5% improved both quality and quantity of protein in pasta. Our results confirmed those obtained by Szczapa *et al.* (1997).

From the same Tables, it could be noticed that, as the level of replacement increased, values of mineral content in spaghetti samples increased. The highest mineral content was found in spaghetti replaced with raw faba bean flour especially in contents of calcium, magnesium, sodium, cupper and zinc. While, potassium and iron contents were increased in spaghetti samples replaced with raw lentil flour at all levels of replacement.

Table (5): Chemical composition of spaghetti replaced with raw, germinated and blanched faba bean flours (on dry weight basis).

Components %	Control	Spaghetti replaced with different forms of faba bean flour														
		Raw					Germinated					Blanched				
		10%	15%	20%	25%	30%	10%	15%	20%	25%	30%	10%	15%	20%	25%	30%
Protein	12.30	15.18	16.03	16.90	17.76	18.62	15.33	16.25	17.19	18.12	19.05	15.02	15.79	16.58	17.36	18.13
Fat	0.91	1.79	1.77	1.75	1.74	1.72	1.85	1.83	1.81	1.79	1.77	1.76	1.74	1.71	1.68	1.65
Ash	0.80	1.94	2.05	2.15	2.23	2.34	1.97	2.10	2.21	2.33	2.44	1.91	2.02	2.10	2.16	2.24
Fiber	0.65	3.10	3.35	3.60	3.87	4.12	3.21	3.53	3.82	4.17	4.47	3.13	3.38	3.65	3.90	4.20
Total carbohydrates	85.34	78.11	76.92	75.67	74.47	73.25	77.74	76.29	74.97	73.59	72.27	78.18	77.07	75.96	74.90	73.78
Element (mg/100g)																
Calcium	40.35	59.12	66.51	75.20	83.37	92.19	56.43	64.28	72.36	80.27	88.40	57.31	65.28	73.61	82.19	90.38
Magnesium	85.62	108.28	115.43	124.62	134.59	142.60	101.40	108.53	115.39	122.40	129.28	104.61	113.20	121.64	130.22	138.41
Sodium	0.89	28.14	42.50	56.31	71.28	85.72	27.12	40.83	54.74	68.56	82.39	27.48	41.37	55.42	69.50	83.30
Potassium	98.21	163.70	195.65	227.49	257.17	289.81	120.43	130.21	141.00	150.27	161.78	135.19	153.40	170.12	187.09	207.86
Cupper	0.29	0.63	0.78	0.92	1.05	1.20	0.59	0.72	0.87	0.98	1.10	0.61	0.76	0.89	1.00	1.15
Zinc	1.93	3.00	3.41	3.90	4.32	4.77	3.10	3.54	4.04	4.50	4.97	2.90	3.28	3.71	4.12	4.49
Iron	2.32	2.96	3.18	3.39	3.58	3.79	3.07	3.26	3.45	3.67	3.89	2.92	3.16	3.29	3.46	3.68

Table (6): Chemical composition of spaghetti replaced with raw, germinated and blanched lentil flours (on dry weight basis).

Components %	Control	Spaghetti with different forms of lentil flour														
		Raw					Germinated					Blanched				
		10%	15%	20%	25%	30%	10%	15%	20%	25%	30%	10%	15%	20%	25%	30%
Protein	12.30	15.07	15.86	16.67	17.47	18.27	15.50	16.44	17.41	18.39	19.36	14.98	15.68	16.40	17.15	17.80
Fat	0.91	1.77	1.75	1.73	1.71	1.70	1.92	1.98	2.02	2.10	2.13	1.74	1.70	1.67	1.65	1.61
Ash	0.80	1.85	1.90	1.96	2.00	2.07	1.88	1.96	2.00	2.09	2.15	1.80	1.84	1.88	1.90	1.93
Fiber	0.65	2.67	2.72	2.77	2.81	2.87	2.75	2.83	2.91	2.97	3.05	2.74	2.82	2.89	2.92	3.00
Total carbohydrates	85.34	78.64	77.77	76.87	76.01	75.09	77.95	76.79	75.66	74.45	73.31	78.74	77.96	77.16	76.38	75.66
Element (mg/100g)																
Calcium	40.35	46.28	48.31	50.94	53.46	55.57	42.69	43.87	44.16	44.79	45.28	43.61	45.72	46.80	48.14	49.35
Magnesium	85.62	96.42	101.29	106.38	110.17	114.35	94.58	97.60	101.42	105.16	108.27	96.89	99.82	104.39	107.51	110.97
Sodium	0.89	16.36	23.71	30.84	38.20	46.74	12.95	18.59	23.30	41.70	35.18	14.81	21.90	27.64	34.80	42.59
Potassium	98.21	221.30	280.65	342.41	400.57	392.26	190.48	237.73	283.29	379.94	400.00	206.56	260.45	312.08	368.65	419.38
Copper	0.29	0.44	0.48	0.51	0.55	0.59	0.42	0.45	0.48	0.50	0.53	0.43	0.46	0.50	0.54	0.57
Zinc	1.93	2.29	2.37	2.48	2.51	2.58	2.40	2.52	2.61	2.89	3.23	2.21	2.30	2.41	2.47	2.52
Iron	2.32	3.18	3.43	3.67	3.91	4.15	3.28	3.60	3.87	4.24	4.49	3.12	3.34	3.58	3.83	4.00

These results are in agreement with those obtained by Bahnassey *et al.* (1986) who found that mineral content of fortified spaghetti with 10 and 15% of nonroasted or roasted navy, pinto beans and lentil flours was considerably higher than the control sample.

Cooking quality :

Cooking quality of spaghetti replaced with raw, germinated and blanched faba bean and lentil flours are presented in Tables (7 and 8). The results showed that, replacement with both different forms of faba bean or lentil flours caused gradually reduction in cooked weight and volume of spaghetti with the increase of replacement level compared to the control sample (100% wheat flour).

Table (7): Cooking quality of spaghetti replaced with raw, germinated and blanched faba bean flours.

Spaghetti samples		Change in cooked weight		Change in cooked volume		Change in cooked loss	
		%	Relative value	%	Relative value	%	Relative value
Control (100% wheat flour)		310.84	100.00	291.71	100.00	6.46	100.00
Spaghetti replaced with raw faba bean flour at levels of :							
	10%	282.96	91.03	243.50	83.47	7.33	113.47
	15%	271.75	87.42	226.23	77.55	7.85	121.52
	20%	260.43	83.78	209.11	71.68	8.29	128.33
	25%	238.50	76.73	194.42	66.65	8.71	134.83
	30%	227.21	73.09	181.68	62.28	9.30	143.96
Spaghetti replaced with germinated faba bean flour at levels of:							
	10%	294.30	94.67	268.74	92.13	6.73	104.18
	15%	286.52	92.18	254.96	87.40	6.92	107.12
	20%	274.81	88.41	248.35	85.14	7.25	112.23
	25%	253.76	81.64	223.21	76.52	7.68	118.89
	30%	239.48	77.04	208.17	71.36	8.16	126.32
Spaghetti replaced with blanched faba bean flour at levels of:							
	10%	273.85	88.09	231.42	79.33	7.51	116.25
	15%	264.61	85.13	218.60	74.94	7.96	123.22
	20%	251.52	80.92	200.53	68.74	8.42	130.34
	25%	229.70	73.89	182.91	62.70	8.90	137.77
	30%	215.43	69.31	170.74	58.53	9.57	148.14

The reduction in cooked weight and cooked volume was greater in spaghetti samples replaced with blanched lentil flour than samples replaced with different forms of faba bean flour. Also, in the same tables, the results showed that, cooking loss of replaced spaghetti was increased gradually with increase the level of replacement compared to the control spaghetti. The increase of cooked loss in spaghetti samples replaced with raw and blanched lentil flours was higher than samples contained all forms of faba bean flour. Taha *et al.* (1992b) reported that inclusion of 5% soy flour or 5% defatted soy flour in durum semolina (85%) based pasta contained 10% yellow corn flour reduced cooked weight and volume and increased cooked loss in samples.

Table (8): Cooking quality of spaghetti replaced with raw, germinated and blanched lentil flours.

Spaghetti samples		Change in cooked weight		Change in cooked volume		Change in cooked loss	
		%	Relative value	%	Relative value	%	Relative value
Control (100% wheat flour)		310.84	100.00	291.71	100.00	6.46	100.00
Spaghetti replaced with raw lentil bean flour at levels of :							
	10%	277.43	89.25	235.37	80.69	7.51	116.25
	15%	265.92	85.54	218.64	74.95	7.94	122.91
	20%	249.60	80.29	197.19	67.60	8.43	130.49
	25%	226.83	72.97	189.52	64.97	8.86	137.15
	30%	218.51	70.29	175.41	60.13	9.52	147.37
Spaghetti replaced with germinated lentil flour at levels of:							
	10%	304.72	98.03	273.54	93.77	6.64	102.79
	15%	292.90	94.23	261.63	89.69	6.81	105.42
	20%	285.34	91.79	254.82	87.35	7.13	110.37
	25%	269.21	86.61	237.90	81.55	7.45	115.33
	30%	247.51	79.64	219.41	75.22	7.89	122.14
Spaghetti replaced with blanched lentil flour at levels of:							
	10%	268.63	86.42	220.72	75.66	7.68	118.89
	15%	257.14	82.72	204.30	70.04	8.12	125.70
	20%	243.86	78.45	187.24	64.19	8.59	132.97
	25%	220.59	70.97	176.18	60.40	9.23	142.88
	30%	209.48	67.39	162.95	55.86	9.64	149.23

Similar trend of results were obtained by Adams (1987) and Buck *et al.* (1987). They reported that replacement of semolina with 5 and 10% of soy flour or with 10 and 20% defatted soy flour decreased the cooked weight and volume and increased the cooked loss in the manufactured pasta. Such findings were obtained by Bahnassey and Khan (1986). As they reported that spaghetti made from durum wheat blended with 3% vital wheat gluten and fortified with 5, 10, 15, 20 and 25% of nonroasted or roasted navy, pinto, or lentil flours showed a decrease in cooked weight and increase in cooked loss as the level of substitution increased.

Colour evaluation :

Data presented in Tables (9 and 10) show Hunter colour values of spaghetti replaced with different forms of faba bean and lentil flours at levels 10, 15, 20, 25 and 30%. Spaghetti samples replaced with raw and processed (germinated and blanched) faba bean flours had an acceptable colour at all levels of replacement. Samples contained raw and germinated lentil flours were more redness than control and spaghetti samples contained all levels of raw, germinated and blanched faba bean flours. As general, replacement with different forms of faba bean flour tend to slightly decrease in lightness (L) values and slightly increase in redness (a) and yellowness (b) values while, L, a and b values were changed greatly in the spaghetti samples replaced with raw and germinated lentil flours compared with control sample. The last effects were increased as the replacement level increased. These results are in agreement with those obtained by Buck *et al.* (1987).

Table (9): Hunter colour values of spaghetti replaced with raw, germinated and blanched faba bean flours.

Spaghetti samples		L	a	b	a/b	Saturation	Hue	ΔE*
Control (100% wheat flour)		86.31	1.06	11.55	0.09	11.55	84.76	-
Spaghetti replaced with raw faba bern flour at levels of :								
	10%	82.75	1.83	12.46	0.15	12.59	81.64	3.74
	15%	82.07	1.79	12.53	0.14	12.66	81.86	4.41
	20%	81.44	1.76	12.75	0.13	13.76	82.14	5.37
	25%	80.56	1.72	13.72	0.13	13.83	82.85	6.18
	30%	79.60	1.69	14.45	0.12	14.55	83.33	7.34
Spaghetti replaced with germinated faba bean flour at levels of :								
	10%	83.79	1.75	12.39	0.14	12.51	81.51	2.79
	15%	83.65	1.72	12.47	0.14	12.59	81.83	2.92
	20%	82.41	1.65	13.28	0.12	13.38	82.92	4.33
	25%	82.25	1.58	13.46	0.12	13.55	82.30	4.54
	30%	81.92	1.45	13.71	0.11	13.79	83.96	4.93
Spaghetti replaced with blanched faba bean flour at levels of :								
	10%	85.64	1.49	11.83	0.13	11.92	82.82	0.86
	15%	85.29	1.32	11.94	0.11	12.01	83.69	1.14
	20%	84.70	1.30	12.19	0.11	12.26	83.91	1.77
	25%	84.56	1.25	12.60	0.10	12.66	84.33	2.08
	30%	83.45	1.16	13.26	0.09	13.31	85.00	3.36

* Colour difference

Table (10): Hunter colour values of spaghetti replaced with raw, germinated and blanched lentil flours.

Spaghetti samples		L	a	b	a/b	Saturation	Hue	ΔE*
Control (100% wheat flour)		86.31	1.06	11.55	0.09	11.55	84.76	-
Spaghetti replaced with raw lentil flaur at levels of:								
	10%	81.83	4.38	12.55	0.35	13.22	70.76	5.66
	15%	80.64	4.53	12.61	0.36	13.33	70.24	6.73
	20%	79.15	5.60	13.81	0.41	14.90	67.93	8.77
	25%	78.44	5.71	13.94	0.41	15.06	67.73	9.45
	30%	77.49	6.10	14.36	0.42	15.60	66.98	10.54
Spaghetti replaced with germinated lentil flour at levels of:								
	10%	79.72	4.15	13.51	0.31	14.20	72.92	7.54
	15%	79.53	4.32	13.86	0.31	14.58	72.69	7.87
	20%	78.37	4.84	14.62	0.33	15.40	71.68	9.31
	25%	77.46	4.96	14.70	0.34	15.51	71.35	10.17
	30%	75.74	5.32	15.22	0.35	16.21	70.73	11.97
Spaghetti replaced with blanched lentil flour at levels of:								
	10%	83.61	1.81	12.05	0.15	12.19	81.46	2.85
	15%	83.18	1.60	12.26	0.13	12.36	82.56	3.25
	20%	82.90	1.43	13.10	0.11	13.18	83.77	3.76
	25%	82.40	1.35	13.23	0.10	13.30	84.17	4.27
	30%	81.46	1.28	13.54	0.09	13.60	84.60	5.25

* Colour difference

Who reported that replacement of pasta samples with 10 and 20% of defatted soy flour tend to reduce the lightness (L) values, rasie the redness (a) and yellowness (b) values.In this respect Taha *et al.* (1992a) found that, browness was increased in pasta samples contained 5% soy flour or 5% defatted soy flour.

From the same tables, spaghetti replaced with blanched faba bean flour at levels 10 and 15% were the best samples for colour attributes and approached to the results of control. Spaghetti samples contained all levels of blanched lentil flour had an acceptable colour values but slightly lower than those of samples contained blanched faba bean flour at the same levels of replacement. These results are in agreement with those obtained by Nielsen *et al.* (1980). Who stated that, spaghetti samples fortified with raw, cooked pea flour and raw, cooked pea protein concentrate at level 33% were increased in lightness (L) and decreased in yellowness (b) values compared with control.

Sensory evaluation :

Data presented in Tables (11, 12 and 13), show the sensory evaluation of spaghetti replaced with raw, germinated and blanched faba bean and lentil flours at different levels respectively. The score values of all sensory attributes were high in control sample among the samples investigated. Results of sensory evaluation indicated that spaghetti samples replaced with blanched legume flours at all levels had the highest score for all sensory characteristics, while, samples replaced with raw flours represented the lowest score compared with control. Replacement of all forms of lentil flour for spaghetti samples tend to reduce the score values for all sensory characteristics compared with that replaced with faba bean flours at all levels. As can observed from results of spaghetti replaced with raw faba bean flour presented in table (11), there was no significant differences between replacement levels 15 and 20% regarding appearance and stickiness. The same observation was found in colour and tenderness between levels 20 and 25%. No significant differences were detected regarding the colour and taste of samples as a result of the presence of raw faba bean flour between levels 10 and 15%. Moreover from the same table , spaghetti samples replaced with raw lentil flour had no significant differences in colour and taste between levels 10 and 15%. Colour of samples at levels 20 and 25% was not different. In regard to tenderness and stickiness, there was no significant differences between samples contained raw lentil flour at levels 15 and 20%. Replacement with raw lentil flour had no effect at levels 25 and 30% on taste, tenderness and stikiness of spaghetti samples.

On the other hand data presented in table (12) showed that, samples replaced with germinated faba bean at levels 10 and 15% had no significant differences for all sensory characteristics. In regard to apperance and stickiness for samples at levels 20 and 25%, no significant differences were detected between them. The same observation was found between levels 25 and 30% for taste and tenderness.

Table (11): Statistical evaluation of sensory characteristics for spaghetti samples replaced with raw faba bean and lentil flours.

Characteristics	Control	Spaghetti replaced with different levels of raw faba bean flour					Spaghetti replaced with different levels of raw lentil flour					LSD 0.05
		10%	15%	20%	25%	30%	10%	15%	20%	25%	30%	
Appearance (10)	9.02^{a}	8.74^{ab}	8.58^{b}	8.30^{b}	7.72^{c}	7.24^{d}	8.70^{ab}	8.46^{b}	7.74^{c}	7.20^{d}	5.94^{e}	0.44
Colour (10)	9.46^{a}	9.28^{ab}	9.14^{ab}	8.60^{b}	8.54^{b}	8.18^{bc}	7.36^{c}	7.19^{c}	6.82^{cd}	6.64^{cd}	6.22^{d}	0.86
Taste (10)	8.70^{a}	8.56^{ab}	8.36^{ab}	8.20^{b}	7.16^{cd}	6.78^{d}	8.54^{ab}	8.27^{ab}	7.40^{c}	7.16^{cd}	6.96^{cd}	0.50
Tenderness(10)	7.74^{a}	7.25^{ab}	7.08^{b}	6.70^{bc}	6.57^{bc}	6.30^{c}	7.04^{b}	6.82^{bc}	6.50^{bc}	6.32^{c}	6.06^{c}	0.66
Stickiness (10)	7.38^{a}	7.06^{ab}	6.82^{b}	6.76^{b}	6.30^{bc}	5.86^{c}	6.92^{ab}	6.48^{b}	6.37^{b}	5.80^{c}	5.45^{c}	0.56
Total (50)	42.30	40.89	39.98	38.56	36.29	34.36	38.56	37.22	34.83	33.12	30.63	

* Any two means have the same letters at the same raw are not significant at $P \leq 0.05$.

Table (12): Statistical evaluation of sensory characteristics for spaghetti samples replaced with germinated faba bean and lentil flours.

Characteristics	Control	Spaghetti replaced with different levels of germinated faba bean flour					Spaghetti replaced with different levels of germinated lentil flour					LSD 0.05
		10%	15%	20%	25%	30%	10%	15%	20%	25%	30%	
Appearance(10)	9.02^{a}	8.94^{ab}	8.62^{ab}	8.50^{b}	8.21^{b}	7.73^{c}	7.44^{c}	7.32^{cd}	6.94^{d}	5.88^{e}	5.66^{e}	0.48
Colour(10)	9.46^{a}	9.25^{ab}	8.96^{ab}	8.64^{b}	8.40^{bc}	7.86^{c}	7.67^{cd}	7.21^{cd}	7.08^{d}	5.40^{e}	5.02^{e}	0.78
Taste(10)	8.70^{a}	8.58^{ab}	8.40^{ab}	8.29^{b}	8.19^{bc}	8.04^{bc}	7.90^{c}	7.64^{cd}	7.45^{d}	7.36^{d}	7.14^{d}	0.38
Tenderness(10)	7.74^{a}	7.62^{ab}	7.55^{ab}	7.40^{ab}	7.30^{b}	7.18^{b}	7.34^{ab}	7.20^{b}	7.12^{bc}	6.96^{bc}	6.73^{c}	0.42
Stickiness(10)	7.38^{a}	7.16^{ab}	6.98^{ab}	6.76^{b}	6.50^{b}	6.37^{bc}	6.91^{ab}	6.7[illegible] ^{b}	5.81^{c}	5.71^{c}	5.48^{c}	0.61
Total (50)	42.30	41.55	40.51	39.59	38.60	37.18	37.26	36.13	34.40	31.30	30.03	

* Any two means have the same letters at the same raw are not significant at $P \leq 0.05$.

Table (13): Statistical evaluation of sensory characteristics for spaghetti samples replaced with blanched faba bean and lentil flours.

Characteristics	Control	Spaghetti replaced with different levels of blanched faba bean flour					Spaghetti replaced with different levels of blanched lentil flour					LSD 0.05
		10%	15%	20%	25%	30%	10%	15%	20%	25%	30%	
Appearance(10)	9.02 d	8.96 ab	8.78 ab	8.62 b	7.91 c	7.74 cd	8.56 b	8.38 b	7.62 cd	7.48 d	7.17 d	0.38
Colour (10)	9.46 a	9.38 ab	9.06 ab	8.94 b	7.88 c	7.56 c	8.82 b	8.54 b	7.50 cd	7.04 d	6.82 d	0.51
Taste (10)	8.70 a	8.52 ab	8.36 ab	8.21 b	8.00 bc	7.84 bc	8.40 ab	7.68 c	7.56 cd	7.18 d	6.73 d	0.48
Tenderness(10)	7.74 a	7.68 ab	7.43 ab	7.24 b	7.16 bc	6.92 bc	7.22 bc	7.06 bc	6.98 bc	6.74 c	6.45 c	0.49
Stickiness (10)	7.38 a	7.22 ab	7.04 ab	6.71 b	6.43 b	6.18 bc	7.10 ab	6.96 ab	6.42 b	5 76 c	5.34 c	0.66
Total (50)	42.30	41.76	40.67	39.72	37.38	36.24	40.10	38.62	36.08	34 20	32.51	

* Any two means have the same letters at the same raw are not significant at $P \leq 0.05$.

Results in the same table indicated that replacement with germinated lentil flour had no effect on apperance between levels 25 and 30% or colour between levels 10 and 25% or between 25 and 30%. The same result was observed for taste and stickiness between levels 20, 25 and 30% and tenderness between levels 20 and 25%.

As shown in table (13), no effect on all sensory characteristics between levels 10 and 15% in samples contained blanched faba bean flour. Colour, taste and tenderness were not different between levels 25 and 30%. Similar result was found for stickiness between levels 20 and 25%. Also, it could be noticed in the same table that, the replacement with blanched lentil flour caused a significant differences in taste between levels 10, 15 and 20%. Also, the same effect was noticed in apperance, colour, taste and stickiness at level 20%. There was no significant differences in apperance, taste and stickiness between levels 10, 15 and 20% for tenderness. All sensory attributes were similar between levels 25 and 30%.

Finally, it can be concluded from these results that, acceptable spaghetti samples could be produced using raw and blanched faba bean flour until 20%, germinated faba bean flour reached to 25% and different forms of lentil flour up to 15%.

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التقييم الغذائي للأسباجتي المصنعة بالاستبدال ببعض دقيق البقوليات الخام والمعامل بطرق تكنولوجية مختلفة

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تم استخدام دقيق الفول والعدس (الخام والمنبت لمدة ٣ أيام والمعامل بالسلق على ١٠٠°م لمدة ٢٠ دقيقة للعدس، ٥٠ دقيقة للفول) مع دقيق القمح (استخلاص ٧٢%) لصناعة مكرونة أسباجتي عالية القيمة الغذائية حيث تم استبدال دقيق القمح بدقيق الفول والعدس بكافة أنواعه بنسب ١٠، ١٥، ٢٠، ٢٥ وكذلك ٣٠%. وقد تم تقدير التركيب الكيماوي والخصائص الوظيفية لأنواع دقيق البقوليات المستخدم في الأستبدال وكذلك تركيب الأحماض الأمينية والـ Chemical Score للمواد الخام المستخدمة. وأيضا تم تقدير التركيب الكيماوي للمكرونة المنتجة ودراسة تأثير هذه المواد على جودة طبخ المكرونة بالإضافة إلى تقييم اللون ثم إجراء التقييم الحسي للناتج النهائي. وقد أظهرت نتائج الدراسة ارتفاع محتوى البروتين لدقيق البقوليات (الفول والعدس) المنبت لمدة ٣ يوم وزيادة قيم بعض الصفات الوظيفية للدقيق المعامل بالإنبات مثل امتصاص الماء والزيت وسعة الرغوة وكذلك قيم الذوبانية للبروتين على نطاق pH من ١-١٠. كما لوحظ إحتواء دقيق البقوليات المستخدمة على مجموع أحماض أمينية أساسية وغير أساسية أعلى من دقيق القمح. وأظهرت نتائج الأسباجتي المصنعة حدوث زيادة في جميع مكونات التركيب الكيماوي عدا الكربوهيدرات الكلية وكذلك زيادة المحتوى المعدني للأسباجتي المحتوية على دقيق الفول والعدس بأنواعه المختلفة لجميع نسب الأستبدال بالمقارنة بالكنترول وكانت أعلى زيادة للبروتين في الأسباجتي المحتوية على دقيق العدس المنبت وأعلى محتوى معدني كان في الأسباجتي المحتوية على دقيق الفول الخام حيث كان عاليا في الكالسيوم والماغنسيوم والصوديوم والنحاس والزنك بينما ارتفع البوتاسيوم والحديد في الأسباجتي المحتوية على دقيق العدس الخام لجميع نسب الأستبدال بالمقارنة مع جميع العينات. وبصفة عامة استخدام دقيق الفول والعدس بصوره المختلفة أدى إلى خفض التغير في الوزن والحجم وزيادة التغير في الفقد بالطبخ للأسباجتي بزيادة معدل الأستبدال عن الكنترول. وكانت الأسباجتي المصنعة من دقيق الفول بصوره المختلفة أفضل في قيم lightness (L)، redness (a) وذات لون مقبول عن تلك المصنعة من دقيق العدس عند نفس نسب الأستبدال، وأوضحت نتائج التقييم الحسي حصول عينات الأسباجتي المحتوية على دقيق الفول بصوره المختلفة على أعلى قيم للصفات الحسية عن تلك المحتوية على دقيق العدس لجميع نسب الأستبدال بالمقارنة مع الكنترول وأنه يمكن إنتاج اسباجتي ذو صفات حسية مقبولة باستخدام دقيق الفول الخام والمسلوق حتى مستوى ٢٠%، دقيق الفول المنبت حتى مستوى ٢٥% وكذلك بجميع صور دقيق العدس حتى مستوى ٢٥% أستبدال لدقيق القمح.