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PRODUCTION AND EVALUATION OF HIGHLY PROTEIN BAKERY PRODUCTS BY USING LEGUMES

BY

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ABSTRACT

The purpose of this study is to produce highly protein bakery products by using locally legumes flour (Cow pea, Lentil, Faba bean and Kidney bean). They were used in two methods non-germinated and germinated. They had been used to produce two kinds of cookies: vanilla and cinnamon cookies supplemented with different legumes flour at level of 40 and 50%, and the resulted cookies were organolyptically evaluated and it was found that cinnamon cookies supplemented at level of 40% of legumes flour got the best acceptance for all types of produced cookies. Therefore it was chosen for evaluating chemical composition, nutritional value and rheological properties. The results of this study showed that legumes flour and produced cinnamon cookies supplemented with 40% legumes flour contained high amount of protein, fat, ash and crude fiber, and contained low amount of total carbohydrates compared with wheat flour and un-supplemented cookies. Germination for all used legumes led to increase protein content, ash, essential amino acids and minerals, also the same trend for supplemented produced cookies. Both of PER and BV of the supplemented cookies were improved compared with un-supplemented ones. The rheological properties of the dough indicate that mixed flour is more suitable for cookies making of good technological properties. The results showed that, 100 gm of cookies supplemented with 40% legumes flour would contribute (51.68-56.21%) of the RDA of protein for children and (24.95-27.14%) for adults.

INTRODUCTION

Baked products are consumed world wide .In Egypt nutritional style bakeries are one of the important protein and calorie sources because it is the most food consumption by Egyptian. Therefore fortification with high protein legume flour (Cow pea, Lentil, Faba bean and Kidney bean) provides a good opportunity to improve the nutritional quality of protein.

Legumes are the edible dicotyledonous seed of plants belonging to the family *Leguminasae* . Legumes are an economical source of protein and calories as well as certain minerals and vitamins essential to human nutrition. The nutritional value of legumes is suggested by the ability of vegetarians to maintain good health on a carefully selected diet and by the fact that severe calorie malnutrition can be cured by an appropriate mixture of cereal and legumes without source of animal protein (Bahnaessey and Harrold, 1986 and Salem *et al.*, 1994)

Certain combination of cereals and legumes can be very desirable from nutritive stand point. Legumes are good sources of lysine and total protein than cereals, while cereals represent superior sources of sulfur amino acids. Therefore the amino acids balance could be improved by preparing some blends of both (Almedia-Dominguez *et al.*, 1990 and Abdel-lateef, Bothayna, 1995).

Germination is a main process which is carried out to improve the nutritive quality and sensory attributes of legume seeds. Many researchers (Hsu *et al.*, 1980;King and Puwastien, 1987;Youssef *et al.*, 1987 and Akinlosotu and Akinyele., 1991 and Mubarak, 2005)had reported that the germination of seeds appears to increase the nutritive value of the product compared with the dry seeds the protein content of legumes increased .The oligosaccharides were hydrolyzed during germination .Aspartic acid, cystin, histidine and ascorbic acid content were increased after germination. Kavas and Nehir, (1992)found an increase in protein content total amino acids, riboflavin, iron, zinc and ascorbic acids contents of the germinated lentils and mung bean . Germination led to a considerable increase in the thiamin, riboflavin and niacin content of lentils (Urbano *et al*, 1995). Germination enhances the nutritive value of legumes by inducing the formation of enzymes that eliminate or reduce the anti-nutritional and indigestible factors in legumes (Bau *et al.*, 1997). Phytic acid in legumes was degraded by phytase which was synthesized during germination (Eskin and wiebe, 1983). Germination improve the nutritive value by reducing trypsin inhibitor, tannins and phytic acid and increased the in-vitro protein digestibility by both pepsin and trypsin enzymes (Hamza and Youssef, 1988;Bakr and Dawoud, 1992; Donangelo *et al.*, 1995 and Abdel-Moety, 2002).Germinating lintil for 48 hrs after soaking in water reduced its tannins content by about 42.5% and phytic acid content by about 25.6 % and reduced trypsin inhibitor activity by about 38% (Abou-Samaha, 1983).

Cookies a confectionary favorite product for Egyptian people and are used in their breakfast or at tea time and it can be used successfully as a vehicle nutrient fortification in school feeding programs, it can be used also in particular cases such as emergency rations.

The objective of the present study is to produce high protein cookies by using available high and cheap protein sources from local ingredients such as Cow pea, Lentil, Faba bean and Kidney bean.

MATERIALS AND METHODS

Materials:

Soft and Hard wheat flour (72% extraction rate) were obtained from South Cairo Mills Company, Giza, Egypt. And used to make cookies and all other used materials, used in dough preparation, were obtained from local market in Dokki, Giza Governorate.

Cow pea (*Vigna sinensis*), Lentil (*Lens esculentum*), Faba bean (*Vicia faba*) and Kidney bean (*Phaseolus vulgaris*) were obtained from Legumes Research Department, Field Crops Research Institute, Agriculture Research Center, Giza, Egypt .

Method:

1- Preparation of legumes flour:

a) Non-Germinated legumes flour:

The raw seeds of legumes were cleaned then were finely ground with hulls.

b) Germinated legumes flour:

Legumes seeds were germinated according to Marero *et al.*, (1988) methods as follows:- Samples of legumes seeds were first rinsed with tap water, then soaked in tap water (1:3 W/V) for 24 hr. and the soaked seeds were washed with tap water and were spread on perforated trays lined with cheese cloth .The seeds were allowed to germination for 48 hr. in the dark at room temperature (25-27 °C).During this period, seeds were rinsed three times daily with water. Germinated seeds were dried at 50 °C in an electric oven; over night. The germinated dried seeds were finely ground with hulls. Germinated kidney bean was not used because the percentage of germination by this method was less than 20% and need long period and this caused growth of molds was detected on germinated seeds.

2-blends:

Soft wheat flour (SWF) used to make control cookies. The legume-wheat flour blends were formulated on a replacement basis hard wheat flour (HWF) at levels of 40 and 50% by using non-germinated and germinated legumes flour (% wet gluten in SWF was 22 %, HWF was 34% and legume-wheat flour blends at levels of 40 and 50% were ranged from 18% to 21.6%).

Preparation of cookies:

Cookies were prepared according to the standard procedure for semi-soft sweet cookies at Bisco Misr plant, Cairo. With some modification .The formula was as in table (1).

Table (1): The formula of cookies.

Ingredients*	Amounts (gm)	%
Flour	100	51.15
Sugar	40	20.46
Butter milk	13	6.65
Corn oil	13	6.65
Dry skim milk	0.5	0.26
Baking powder	3	1.53
Egg (whole fresh)	25	12.79
Vanilla or cinnamon	1	0.51
Total	195.5	100

* The ingredients gave 175.95 (gm) cookies.

For making cookies, we followed the following procedure:-Sugar, oil and butter milk were creamed by using a mixing machine for 1 min. Eggs were beaten and vanilla was added to the beaten eggs. Sugar-oil-butter cream was added gradually to Egg-Vanilla mixture and well beaten at low speed for 5 min, dry ingredients were stirred together and added to mixture gradually and the mixtures beaten continuously until the blend became smooth, the resulted dough was let to rest for 15 min. The dough was rolled in a cookie sheet using a guide

roll the dough was cut in circles (0.3 cm thick and 4cm diameter) .Transferred to greased plate, then baking process was carried out in electrically heated oven at 170 °C for 12 – 15 min. After baking, cookies were allowed to cool at room temperature for 1hr. before organoleptic evaluation.

Chemical analysis:

Samples were chemically analyzed for moisture, protein, fat, ash and crude fiber according to the methods described in A.O.A.C. (2000). Total carbohydrates were calculated by difference .The approximate energy of cookies was calculated according to the (FAO/ WHO, 1974) as follows:-

Total energy (K.cal) =4(Carbohydrate + Protein) +9Fat.

Protein energy of cookies was expressed in terms of its energy as a percentage of total energy according to Cameron and Hofvander (1983).

Determination of minerals content:

Minerals, i.e., Zn, Mn, Fe, Ca, Mg, and K were determined in the diluted solution of ash samples by using the atomic absorption spectrophotometer (3300 Perkin-Elmer) as described in A.O.A.C.(1995).

Determination of amino acids:

Amino acids were determined according to the method described by Winder and Egyum, (1966).Using a LC3000 Amino Acid Analyzer Eppendrof-Germany.

The amino acids Score (AAS) was calculated according to the FAO/WHO (1973) as follows:-

$$\text{AAS (\%)} = \frac{\text{mg .of amino acids in 1 gm test protein}}{\text{mg .of amino acids in reference protein}} \times 100$$

Protein Efficiency Ratio (PER) was estimated using the equation reported by Alsmeyer *et al.*, (1974)as follows:-

PER = 0.684 + 0.456 (Leucine) – 0.047 (Proline)

Biological value (BV) was estimated using the equation suggested by Mitchel and Block (1946) as follows:-*BV=49.9+10.53 PER*

Sensory evaluation of cookies:

Cookies produced were evaluated for their sensory characteristics by ten panelists from the staff of bread and pastry, Research Dep., Agric. Res. Center, Giza. The scoring scheme was established as mentioned by Mohamed, Thanaa, (2000) as follows: color of crust (20), taste (20), odor (20), appearance (20), crunchiness (20) and total score 100 degrees. The data obtained from sensory evaluation were statistically analyzed by analysis of variance using the general linear model (GLM) procedure within statistical analysis system (SAS, 1987).

Rheological properties:

The characteristics of dough, which was made from the raw mixtures were measured by means of farinograph (877563 Brabender-Farinograph, West-

Germany HZ50) and extensograph (4821384 Brabender – Extensograph, West – Germany HZ 50) according to the methods described in A.A.C.C.(1990).

RESULTS AND DISCUSSION

Soft wheat flour 72%ex. (SWF) which is desirable for good cookies-making quality (Gaines, 1985 and Labuschagne *et al.*, 1996). In the same time several investigators found that the maximum replacement was at level 15% of the SWF in cookies formulas without adversely affecting baking performance, physical characteristics and acceptability (Hegazy, Nefisa and Faheid, Siham, 1991).Therefore in this study, hard wheat flour 72% ex. (HWF) was used to make high replacement ratio of legumes flour 40 % and 50 % (supplemented cookies) while SWF was used to make un-supplemented cookies (control).

Chemical composition of raw materials:

Data presented in table (2) show the chemical composition of raw materials used for the preparation of cookies. It could be demonstrated that HWF was high in its content of protein, fat, ash, and crude fiber and have low amount of total carbohydrate compared with SWF. These results are in accordance with those mentioned by Farvili *et al.*, (1997) and Atia (2004).On the other hand legumes flour (Cow pea, lentils, faba bean and kidney bean) non-germinated (N.G) and germinated (G) recorded high amounts of protein, fat, ash and crude fiber and have low amount of total carbohydrate compared with two kinds of wheat flour HWF and SWF .Also from the same table, the results showed that germination of legumes for 48hr. after soaking for 24hr. led to increasing the protein content and slight increasing in fat and ash content while the carbohydrate content and crude fiber decreased compared with non –germinated of legumes .The increase in protein content may be due to the biosynthesis of new protein or new enzymes required for germination or may be due to the consumption of the other stored components. The results were obtained in agreement with those of Hsu *et al.*, (1980); Akinlosotu and Akinyele (1991) and Donangelo *et al.*, (1995).

Mineral contents of raw materials:

Mineral contents of raw materials constitute a very important for food mixtures. Calcium, iron, magnesium, and zinc are the most important for physiological requirements of children. For example calcium is combined as the salts that give hardness to bones and teeth; iron is required for an expanding blood volume and increasing amounts of hemoglobin in growing children; magnesium is essential for all living cell, it is a catalyst in numerous metabolic reaction and zinc as an integral part of least 20 enzymes that belong to a large group known as metabloenzymes (Robinson and Lawler, 1977) .

Data in table (3) showed some minerals content (i.e., zinc, manganese, iron, calcium, magnesium and potassium) of the tested raw materials. It revealed that non-germinated and germinated legumes flour were extremely rich in minerals as compared with wheat flour (SWF and HWF). These results are agree with those found by Pellett and Shadarevian (1970) .On the other hand, the germination process for all used legumes lead to increase for their mineral

content, espeasilly zinc, iron and potassium .These results are in agreement with those reported by Kavas and Nehir (1992) And Khalil and Mansor (1995). Also from table (3) clear that kidney bean contained high amount of zinc, calcium and potassium (5.46, 99.0 and 2775.8 mg/100 gm; respectively); germinated cow pea contained high amount of manganese (4.42 mg/100gm) and germinated faba bean contained high amount of iron (11.32 mg/100 gm).

Table (2): Chemical composition of raw materials used for the preparation of cookies. (% on dry weight basis).

Components	Wheat flour (72%ex.)		Cow pea		Lentils		Faba bean		Kidney bean
	SWF	HWF	N.G	G	N.G	G	N.G	G	N.G
Protein	8.68	12.11	26.83	27.98	27.15	28.19	29.61	30.92	24.71
Fat	0.69	0.89	2.40	2.60	1.60	2.09	1.83	1.95	1.80
Ash	0.49	0.54	4.11	4.53	3.03	3.12	3.63	3.83	3.35
Crude fiber	0.70	0.75	3.89	2.95	7.16	6.50	5.91	4.89	5.03
Total carbohydrates	89.44	85.71	62.77	61.94	61.06	60.10	59.02	58.41	65.11

SWF=Soft wheat flour. **HWF**=Hard wheat flour.
N.G=Non- germinated. **G**= germinated for 48 hr. after soaking for 24 hr.
Not:-don't using kidney bean germinated because germination ratio by using this method less than 20% compared with other legumes (100 %).

Table (3): Minerals content (mg/100gm) of raw materials used for the preparation of cookies.

Minerals	Wheat flour (72%ex.)		Cow pea		Lentils		Faba bean		Kidney bean
	SWF	HWF	N.G	G	N.G	G	N.G	G	N.G
Zn	0.55	0.57	4.51	4.69	3.50	3.90	4.40	4.60	5.46
Mn	1.09	1.19	4.28	4.42	1.29	1.42	1.52	1.43	1.35
Fe	1.89	1.81	9.17	10.20	9.02	9.80	10.92	11.32	7.68
Ca	36.25	36.91	73.3	92.4	94.70	95.17	98.40	97.99	99.0
Mg	123.85	124.91	127.5	138.1	178.40	179.30	372.5	372.1	155.6
K	127.36	128.10	1670	1914	1335	1380	1612	1751	2775.8

SWF=Soft wheat flour. **HWF**=Hard wheat flour. **N.G**=Non- germinated.
G= germinated.

Amino acids content of raw materials:

Since protein quality depends on its content of the essential amino acids as well as the ratio of these amino acids to each other (Food and Nutrition Board Washington, 1974). Results of amino acids analysis are summarized in table (4), in which data indicate that the legumes flour are characterized by high content of indispensable amino acids lysine, leucine, threonine and other amino acids such as histidine, arginine, aspartic and alanine compared to those in wheat flour (SWF and HWF) .However methionine, cystine, phenyl alanine, glutamic acid and proline were higher in wheat flour than in the legumes flour.

Table (4): Amino acids contents of wheat flour and legume flour used for cookies preparation (gm of A.A/100gm protein).

Amino asids (A.A)	Wheat flour		Legumes flour							FAO/ WHO (1973)
	Soft (SWF)	Hard (HWF)	Cow pea		Lentils		Faba bean		Kidney bean	
			N.G	G	N.G	G	N.G	G	N.G	
Essential (E.A.A)										
Lysine	1.18	1.36	7.85	7.94	7.75	7.83	7.14	7.28	7.78	5.5
Iso Leucine	3.89	5.79	5.83	5.89	5.87	5.93	6.86	6.90	5.81	4.0
Leucine	5.91	5.61	7.11	7.65	7.92	8.17	7.04	7.29	8.49	7.0
Methionine*	1.85	1.94	0.50	0.69	0.69	0.98	0.80	0.86	0.77	a+b
Cystine*	1.83	1.97	0.81	0.90	0.72	0.85	0.87	0.95	0.66	3.5
Phenyl alanine*	4.65	5.97	5.70	5.81	4.53	4.65	4.15	4.20	4.51	c+d
Tyrosine*	2.37	2.15	3.52	3.60	3.10	3.21	3.26	3.32	3.49	6.0
Threonine	2.75	2.82	3.22	3.30	3.16	3.27	3.60	3.68	4.14	4.1
Valine	3.99	4.33	3.99	4.05	4.43	4.83	5.30	5.45	4.92	5.0
Tryptoph*	-	-	-	-	-	-	-	-	-	1.0
Total E.A.A	28.42	31.94	38.53	39.83	38.17	39.72	39.02	39.93	40.57	36.0
Non-essntial (N.E.A.A)										
Histidine	1.89	1.82	3.17	3.37	3.87	3.98	3.26	3.39	3.87	
Arginine	2.33	2.99	9.10	8.81	8.23	8.12	9.54	9.44	9.13	
Aspartic	3.89	3.45	9.66	10.24	10.35	11.23	11.21	12.04	10.24	
Serine	5.03	4.43	6.16	5.83	6.45	6.56	5.49	5.84	6.48	
Glutamic	37.13	35.15	17.31	16.99	17.03	16.93	17.39	17.28	17.11	
Proline	13.01	11.39	6.01	5.43	5.35	3.96	4.95	3.89	3.40	
Glycine	3.85	4.82	4.51	4.46	3.97	3.55	4.18	3.94	3.84	
Alanine	2.66	2.40	4.14	4.05	4.24	3.98	3.49	3.38	3.59	
Total N.E.A.A	69.79	66.45	60.06	59.18	59.49	58.31	59.51	59.20	57.66	
Total A.A	98.21	98.39	98.59	99.01	97.66	98.03	98.53	99.13	98.23	
PER	2.77	2.71	3.64	3.92	4.04	4.22	3.66	3.83	4.40	
B.V	79.07	78.44	88.23	91.18	92.44	94.34	88.44	90.22	96.23	

N.G=Non-germinated. **G**= germinated. *Tryptophan was not determined.

Also there was little increased in the essential amino acid content occurred after germination for different legumes flour used .These results coincide with obtained by King and Puwastien, (1987); Hassan, Enayat *et al.*, (1993) and Mubarak (2005). On the other hand both calculated protein efficiency ratio (PER) and biological value (BV) of the legumes flour are higher as compared with wheat flour (SWF and HWF). The highest PER and BV values are for kidney bean flour. Also PER and BV were improved slightly by germination of legumes.

Data presented in table (5) indicate that amino acid score (AAS) of non-germinated and germinated legumes flour are higher than that of wheat flour (SWF and HWF) except the sulphur amino acids (methionine and cystine).

Sensory evaluation of produced cookies:

It has been produced two kinds of cookies (vanilla cookies and cinnamon cookies) supplemented with different legumes flour at level of 40 and 50% .And the resulted cookies were evaluated organolyptically and the obtained data were tabulated in table (6).From this data it could be observed that the highest values for all sensory characteristics were observed in un-supplemented

cookies and cookies supplemented with 40 and 50% kidney bean flour in each of vanilla cookies and cinnamon cookies .And the cinnamon cookies had the highest total score compared with the vanilla cookies, and the supplementation at level 40% of legumes flour was the best acceptance for all types of cookies. Therefore cinnamon cookies at supplementation level of 40% were chosen for evaluating chemical composition, nutritional value and rheological properties.

Table (5): Amino acids scores (AAS) of wheat flour and legumes flour used for cookies preparation.

Essential amino acids (E.A.A)	Wheat flour		Legumes flour						
	Soft (SWF)	Hard (HWF)	Cow pea		Lentils		Faba bean		Kidney bean
			N.G	G	N.G	G	N.G	G	N.G
Lysine	21.45[a]	24.73[a]	142.73	144.36	140.91	142.36	129.82	132.36	141.45
Iso Leucine	97.25	144.75	145.75	147.25	146.75	148.25	171.50	172.5	145.25
Leucine	84.43	80.14	101.57	109.29	113.14	116.7	100.57	104.14	121.29
Methionine +Cystine	105.14	111.71	37.43[a]	45.43[a]	40.29[a]	52.29[a]	47.71[a]	51.71[a]	40.86[a]
Phenyl alanine + Tyrosine	117.0	135.33	153.67	156.83	127.17	131.0	123.5	125.33	133.33
Threonine	67.07	68.78	78.54	80.49	77.07	79.76	87.80	89.76	100.98
Valine	79.8	86.6	79.8	81.0	88.6	96.6	106.0	109.0	98.40

a = The first limiting amino acid. **N.G** = Non-germinated. **G** = germinated.

Chemical composition of cinnamon cookies:

The chemical composition of cinnamon cookies un- supplemented and supplemented with different legumes flour at levels of 40 % were presented in table (7). From the obtained data it could be noticed that supplemented cookies had the highest value of protein, fat, ash and crude fiber and lowest value of total carbohydrate compared with un-supplemented cookies. And the cookies supplemented with germinated legumes flour had the highest value of protein, fat and ash, while it had the lowest value of total carbohydrate and crude fiber compared with cookies supplemented with non-germinated legumes flour. In supplemented cookies had protein content ranged from 14.47-15.74%, fat 17.48-17.68, ash 1.73-2.04%, crud fiber 0.83-1.69%, total carbohydrate 63.69-64.95% and total energy 473.72-476.92 K.cal, while un-supplemented cookies had protein 9.57%, fat 17.28%, ash 1.11%, crud fiber 0.46%, total carbohydrate 71.58% and total energy 480.12 K.cal. It can be also observed that supplementation of cookies with different sources of legumes flour increased the protein energy comparing with the un-supplemented cookies. Cookie supplemented with 40% germinated faba bean flour had the highest ratio of protein content and protein energy compared with other samples of supplemented cookies.

Mineral contents of cinnamon cookies:

The results presented in table (8) showed that cinnamon cookies supplemented with 40% non-germinated or germinated legumes flour had the highest values in minerals content (i.e., zinc, manganese, iron, calcium, magnesium and potassium) compared with un-supplemented cookies. Hence, cookies supplemented with legume flour are favorable than un-supplemented ones, because of their high contents of important minerals.

Table (6): Sensory evaluation of cookies supplemented with legumes flour.

Treatment				Color (20)	Taste (20)	Odor (20)	Appea-rance (20)	Crun-chiness (20)	Total Score (100)	Accep-tance
Vanilla Cookies										
Control (0%)				19^{b}	20^{a}	20^{a}	20^{a}	20^{a}	99^{a}	V
supplemented cookies	N.G.L	Co wpea	40 %	17^{d}	15^{f}	16^{e}	17^{c}	19^{b}	84^{fg}	G
			50 %	15^{f}	14^{g}	15^{f}	16^{d}	18^{c}	78^{k}	S
		lentils	40 %	16^{e}	17^{d}	17^{d}	16^{d}	19^{b}	85^{f}	G
			50 %	14^{g}	16^{e}	17^{d}	15^{e}	18^{c}	80^{j}	G
		Faba bean	40 %	18^{c}	18^{c}	18^{c}	16^{d}	19^{b}	89^{d}	G
			50 %	16^{e}	17^{d}	17^{d}	15^{e}	18^{c}	83^{gh}	G
		Kidney bean	40 %	20^{a}	20^{a}	20^{a}	20^{a}	19^{b}	99^{a}	V
			50 %	20^{a}	19^{b}	19^{b}	20^{a}	18^{c}	96^{b}	V
	G.L	Cow pea	40 %	16^{e}	18^{c}	17^{d}	17^{c}	19^{b}	87^{e}	G
			50 %	15^{f}	17^{d}	16^{e}	16^{d}	18^{c}	82^{m}	G
		Lentils	40 %	16^{e}	18^{c}	18^{c}	17^{c}	18^{c}	87^{e}	G
			50 %	14^{g}	17^{d}	18^{c}	16^{d}	16^{d}	81^{ij}	G
		Faba	40 %	17^{d}	19^{b}	18^{c}	17^{c}	19^{b}	90^{d}	V
			50 %	16^{e}	18^{c}	17^{d}	16^{d}	18^{c}	85^{f}	G
L.S.D$_{0.05}$				0.784	0.741	0.838	0.744	0.727	1.845	
Cinnamon Cookies										
upplemented cookies0	N.G.L	Co wpea	40 %	18^{c}	18^{c}	19^{b}	19^{b}	20^{a}	94^{d}	V
			50 %	17^{d}	16^{e}	18^{c}	18^{c}	17^{d}	86^{g}	G
		lentils	40 %	19^{b}	19^{b}	19^{b}	19^{b}	19^{b}	95^{c}	V
			50 %	17^{d}	18^{c}	18^{c}	18^{c}	17^{d}	88^{f}	G
	N.G.L	Faba bean	40 %	19^{b}	19^{b}	19^{b}	19^{b}	19^{b}	95^{c}	V
			50 %	17^{d}	18^{c}	19^{b}	18^{c}	17^{d}	89^{f}	G
		Kidney bean	40 %	20^{a}	20^{a}	20^{a}	20^{a}	20^{a}	100^{a}	V
			50 %	20^{a}	19^{b}	20^{a}	20^{a}	18^{c}	97^{b}	V
	G.L	Cow pea	40 %	19^{b}	19^{b}	19^{b}	19^{b}	19^{b}	95^{c}	V
			50 %	17^{d}	17^{d}	18^{c}	19^{b}	18^{c}	89^{f}	G
		Lentils	40 %	19^{b}	19^{b}	19^{b}	19^{b}	19^{b}	95^{c}	V
			50 %	17^{d}	18^{c}	18^{c}	18^{c}	18^{c}	89^{f}	G
		Faba	40 %	19^{b}	19^{b}	19^{b}	19^{b}	19^{b}	95^{c}	V
			50 %	18^{c}	18^{c}	19^{b}	18^{c}	18^{c}	91^{e}	V
L.S.D$_{0.05}$				0.567	0.687	0.705	0.612	0.665	1.399	

Each value with the same column is followed by the same letters is not significant different at level of 0.05.

90-100 Very good (V). 80-89 Good (G). 70-79 Satisfactory (S). Less than 70 Questionable (Q) . N.G.L = Non –Germinated legumes.

G.L =Germinated legumes.

Table (7): Chemical composition of cinnamon cookies un- supplemented and supplemented with different legumes flour at level of 40% (% on dry weight basis).

Components	Un-supplemented Cookies	Cookies supplemented with 40%						
		Cow pea		Lentils		Faba bean		Kidney bean
		N.G	G	N.G	G	N.G	G	N.G
Protein (%)	9.57	14.90	15.13	14.96	15.17	15.47	15.74	14.47
Fat (%)	17.28	17.64	17.68	17.48	17.58	17.52	17.55	17.52
Ash (%)	1.11	1.95	2.04	1.73	1.75	1.85	1.89	1.80
Crude fiber (%)	0.46	1.03	0.83	1.69	1.56	1.44	1.23	1.26
Total carbohydrates (%)	71.58	64.48	64.32	64.14	63.94	63.72	63.59	64.95
Total energy (K. cal)	480.12	476.28	476.92	473.72	474.66	474.44	475.27	475.36
Protein energy*	7.97	12.51	12.69	12.63	12.78	13.04	13.25	12.18

N.G=Non- germinated. G= germinated. * as % of total energy.

Table (8): Minerals content (mg/100gm) of cinnamon cookies un-supplemented and supplemented with different legumes flour at level of 40% (% on dry weight basis).

Minerals	Un-supplemented Cookies	Cookies supplemented with 40%						
		Cow pea		Lentils		Faba bean		Kidney bean
		N.G	G	N.G	G	N.G	G	N.G
Zn	0.51	1.42	1.46	1.19	1.28	1.39	1.44	1.64
Mn	0.8	1.55	1.59	0.88	0.91	0.93	0.91	0.89
Fe	1.42	3.05	3.29	3.02	3.2	3.45	3.54	2.71
Ca	29.34	37.98	42.32	42.85	42.95	43.69	43.60	43.82
Mg	72.45	73.64	76.05	58.20	85.41	129.3	129.21	80.02
K	96.94	447.68	503.12	371.57	381.79	434.5	466.08	698.92

N.G=Non- germinated. G= germinated.

Amino acids content of cinnamon cookies:

Table (9) showed that amino acids analysis of various prepared cookies. Results show that the cookies supplemented with 40% non-germinated or germinated legume flour had the highest quantity of lysine, isoleucine, leucine, phenyl alainene, tyrosine, threonine, valine and total essential amino acids (total. E.A.A) and other amino acids such as histidine, arginine, aspartic, glycine and alanine compared to those in un-supplemented cookies. However methionine, cystine, glutamic, prolin and total non-essential amino acids (total. N.E.A.A) were higher in un-supplemented cookies than in supplemented cookies. The protein efficiency ratio (PER) and biological value (BV) of all cookies supplemented with 40% legumes flour were higher compared with un-supplemented cookies.

Data presented in table (10) showed that the amino acid scores (AAS) of all cookies supplemented with 40% legumes flour were higher than that of un-supplemented cookies except the sulfur amino acids (methionin and cystine). This is due the improvement in essential amino acids.

Table (9): Amino acids contents of cinnamon cookies un-supplemented and supplemented with 40%legume flours (gm of A.A/100gm protein).

Amino acids (A.A)	Un-Supplemented Cookies	Cookies Supplemented with 40%legumes flour							FAO/ WHO (1973)
		Cow pea		Lentils		Faba bean		Kidney bean	
		N.G	G	N.G	G	N.G	G	N.G	
Essential (E.A.A)									
Lysine	2.02	4.43	4.45	4.39	4.42	4.20	4.24	4.40	5.5
Iso Leucine	4.23	5.76	5.78	5.78	5.80	6.09	6.11	5.76	4.0
Leucine	6.19	6.63	6.80	6.89	6.97	6.61	6.92	7.07	7.0
Methionine[a]	2.10	1.71	1.77	1.77	1.86	1.81	1.83	1.80	a+b
Cystine[b]	1.88	1.62	1.65	1.60	1.64	1.65	1.67	1.58	3.5
Phenyl alanine[c]	4.8	5.77	5.81	5.40	5.43	5.27	5.29	5.39	c+d
Tyrosine[d]	2.72	2.98	3.00	2.85	2.88	2.90	2.92	2.97	6.0
Threonine	3.22	3.40	3.43	3.39	3.42	3.53	3.55	3.80	4.1
Valine	4.57	4.74	4.75	4.88	5.00	5.16	5.20	5.04	5.0
Tryptophan*	-	-	-	-	-	-	-	-	1.0
Total E.A.A	31.73	37.04	37.44	36.95	37.42	37.22	37.73	37.81	36.0
Non-essntial (N.E.A.A)									
Histidine	1.99	2.37	2.43	2.59	2.63	2.40	2.45	2.59	
Arginine	3.08	5.57	5.47	5.29	5.25	5.71	5.68	5.58	
Aspartic	5.13	6.67	6.85	6.89	7.17	7.16	7.43	6.85	
Serine	5.56	5.62	5.51	5.71	5.75	5.40	5.52	5.72	
Glutamic	32.34	24.95	24.85	24.86	24.83	24.98	24.96	24.89	
Proline	11.28	8.22	8.03	8.00	7.56	7.88	7.54	7.38	
Glycine	3.75	4.42	4.40	4.24	4.11	4.31	4.23	4.20	
Alanine	3.29	3.60	3.57	3.63	3.55	3.39	3.35	3.42	
Total N.E.A.A	66.42	61.42	61.11	61.21	60.85	61.23	61.16	60.63	
Total A.A	98.15	98.46	98.55	98.16	98.27	98.45	98.89	98.44	
PER	2.98	3.32	3.41	3.45	3.51	3.33	3.49	3.56	
B.V	81.24	84.86	85.81	86.23	86.86	84.96	86.65	87.39	

N.G=Non-germinated. G= germinated. *Tryptophan was not determined.

Table (10): Amino acids scores (AAS) of cinnamon cookies un- supplemented and supplemented with 40%legumes flour.

Essential amino asids (E.A.A)	Un-supplemented cookies	cookies Supplemented with 40% Legumes flour						
		Cow pea		Lentils		Faba bean		Kidney bean
		N.G	G	N.G	G	N.G	G	N.G
Lysine	36.73	80.55[a]	80.91[a]	79.82[a]	80.36[a]	76.36[a]	77.09[a]	80.0[a]
Iso Leucine	105.75	144.0	144.5	144.5	145.0	152.25	152.75	144.0
Leucine	88.43	94.71	97.14	98.43	99.57	94.43	98.86	101.0
Methionine + Cystine	113.71	95.14	97.71	96.29	100	98.86	100	96.57
Phenyl alanine + Tyrosine	125.33	145.83	146.83	137.50	138.50	136.17	136.83	139.33
Threonine	78.54	82.93	83.66	82.68	83.41	86.10	86.59	92.68
Valine	91.40	94.80	95.00	97.60	100	103.2	104	100.8

N.G=Non-germinated. G= germinated. a = The first limiting amino acid.

Rheological properties of the dough:

From table (11) the results indicated that the effect of mixing non-germinated and germinated legume flours with hard wheat flour (HWF) on the rheological properties of the mixed dough .For farinogram readings, addition of non-germinated and germinated legumes flour at addition levels of 40% with 60% hard wheat (HWF) led to increase the water absorption of the dough for all mixtures compared with HWF (which is used of making mixtures). The highest increase in water absorption was observed when germinated legumes flour was added to HWF. This could be due to the water holding capacity of germinated legumes flour being higher than non-germinated legumes flour because germination stimulate activation of protease for degradation of protein polymers into monomers protein which highly absorb water. Dough development time increased in germinated legumes flour mixture more than in non-germinated legumes flour mixture due to decrease in dough strength by the activation of enzymes which effect on their substrate of dough components. Also degree of weakening increased, the highest increasing of it was found in non-germinated faba bean mixtures while dough stability time and arrival time decreased for all mixtures, except arrival time of germinated faba bean mixture increased. For extensogram readings the resistance to extension (R) decreased in non-germinated legumes flour mixtures while germinated legumes flour mixtures and non-germinated kidney bean flour mixture increased compared with HWF. The extensibility (E) increased for non-germinated cow pea and lentils mixtures while it decreased in other mixtures compared with HWF. The proportional number (R/E) increased in all mixtures except mixture of non-germinated cow pea and lentils decreased. Dough energy decreased in all mixtures except germinated faba bean mixture increased. SWF was higher in degree of weakening, E and dough energy while it was lower in other readings compared with HWF. By comparison of SWF (which was identified as the control of cookies flour) with different legumes flour mixture used it was found that farinogram readings was high in all mixtures, except arrival time was low for non-germinated legumes flour mixtures. As regard to the extensogram readings R and R/E were high while E and dough energy were low in all mixtures compared with SWF (control). This indicates that mixed flour is more suitable for cookies making of good technological properties.

Percentage of the recommended dietary allowances (% RDA) which are provided of produced cinnamon cookies:

From the data in table (12) it could be observed that 100gm of supplemented cookies with 40% legumes flour cover (51.68-56.21%) of daily protein requirement for children, and (24.95-27.14%) for adults. And all values of % RDA for studied nutrient were high in supplemented cookies compared with un-supplemented cookies as shown in table (12).

Conclusion and recommendation:

From this study it could be concluded that replacement of wheat flour by legumes flour (Cow pea, lentil, faba bean and kidney bean) non-germinated and germinated at level of 40% caused rising in protein content, the amount of essential amino acids, PER, BV and minerals content and improving nutritional values of cookies. And it is recommended to use the mentioned legumes flour especially its germinated on supplemented of wheat flour to improving nutritional value of bakery products.

Table (11): Effect of mixing non-germinated and germinated legumes flour with hard wheat flour (HWF) on the rheological properties of mixed dough.

	Dough mixture	Wheat flour 100%		60 % HWF+ 40% legumes flour						
		Soft (SWF)	Hard (HWF)	Cow pea		Lentils		Faba bean		Kidney bean
				N.G	G	N.G	G	N.G	G	N.G
Farinogram readings	Water absorption(%)	60.1	61.7	64.5	71.6	67.1	82.6	68.2	79.7	69.2
	DoughDevelopment time (min)	2 3/4	3 1/2	4 1/2	5	4	5	4	6 3/4	4
	Dough Stability time(min)	1	5 3/4	3 3/4	3 1/2	3 1/2	2 3/4	2 1/2	1 1/2	3
	Degree of weakening (BU*)	100	50	130	140	185	190	205	120	170
	Arrival time (min)	2 1/2	3 1/2	2 1/4	3	2	3 1/2	2 1/4	6 1/4	2
Extensogram readings	Resistance to extension (R)(BU*)	170	270	175	420	200	330	215	420	400
	Extensibility(E) (mm)	160	108	150	79	112	88	80	100	87
	Proportional number (R/E)	1.1	2.5	1.2	5.3	1.8	3.8	2.7	4.2	4.6
	Dough Energy (cm^2)	83	51	37	49	37	48	23	72	48

SWF = was identified as the control of cookies flour. **HWF** = used for making mixtures.
N.G = Non-germinated. **G** = germinated. *BU= barabender unit.

Table (12): Percentage of the RDA (1989)* for some nutrient provided from 100 gm of cookies for children and adults.

	RDA* (1989)	%RDA**							
		Un-supplemented Cookies	Cookies supplemented with 40%						
			Cow pea		Lentils		Faba bean		Kidney bean
			NG	G	NG	G	NG	G	NG
Children (7-10 years)	Protein (gm) 28	34.17	53.21	54.04	53.43	54.18	55.25	56.21	51.68
	Energy (Kcal) 2000	24.01	23.81	23.85	23.69	23.73	23.72	23.76	23.77
	Zn (mg) 10	5.10	14.20	14.60	11.90	12.80	13.90	14.40	16.40
	Fe (mg) 10	14.20	30.50	32.90	30.20	32.00	34.5	35.40	27.10
	Ca (mg) 800	3.67	4.75	5.29	5.36	5.37	5.46	5.45	5.48
	Mg (mg) 170	42.62	43.32	44.74	50.12	50.24	76.06	76.00	47.07
Adults (19-24 years)	Protein (gm) 58	16.50	25.69	26.09	25.79	26.16	26.67	27.14	24.95
	Energy (Kcal) 2900	16.56	16.42	16.45	16.34	16.37	16.36	16.39	16.39
	Zn (mg) 15	3.40	9.47	9.73	7.93	8.53	9.27	9.60	10.93
	Fe (mg) 10	14.2	30.50	32.90	30.20	32.00	34.50	35.40	27.10
	Ca (mg) 1200	2.45	3.17	3.53	3.57	3.58	3.64	3.63	3.65
	Mg (mg) 350	20.70	21.04	21.73	24.34	24.40	36.94	36.92	22.86

*According to Food and Nutrition Board (1989).

** %RDA= $\frac{\text{Value of nutrient in sample of cookies x100}}{\text{RDA for the same nutrient}}$

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إنتاج وتقييم مخبوزات عالية البروتين باستخدام البقوليات

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أجرى هذا البحث بغرض إنتاج مخبوزات عالية البروتين باستخدام دقيق البقوليات المحليه (اللوبيا- العدس- الفول البلدى- الفاصوليا) فى صورتين غير المنبته والمنبته وتم اعداد نوعان من البسكويت بسكويت الفانيليا وبسكويت القرفه عند نسب إستبدال ٤٠% و ٥٠% بإستخدام دقيق هذه البقوليات وبإجراء التقييم الحسى لنوعى البسكويت الناتج إوضحت النتيجه ان بسكويت القرفه عند مستوى إستبدال ٤٠% هوالافضل فى كل أنواع البسكويت المنتجه لذلك تم إختياره لتقييمه غذائيا ودراسة تأثير نسبة الخلط على الخواص الريولوجيه للعجينه الناتجه فأوضحت نتيجة الدراسه الأتى:- أظهر التحليل الكيميائى لمحتواء دقيق البقوليات المستخدمة وكذلك بسكويت القرفه الناتج من التدعيم ب ٤٠% دقيق البقوليات على أعلى نسبه من البروتين والدهن والرماد وألالياف وأقل نسبه من الكربوهيدرات بالمقارنه بدقيق القمح المستخدم والبسكويت غير المدعم وأدت عملية الإنبات للبقوليات المستخدمه إلى زيادة المحتوى البروتينى والرماد والأحماض الأمينيه الاساسيه والعناصر بالمقارنه بمثيلتها غير المنبته وكذلك كان الحال بالنسبه للبسكويت المدعم بها ووجد أن معامل الاستفاده من البروتين والقيمه الحيويه

للبروتين فى البسكويت المدعم زادت بالمقارنه بالبسكويت غير المدعم وكانت قـراءات الفارينوجراف أعلى فى كل الخلطات الناتجه بإستخدام الدقيق القوى والذى تم إستخدامه فى عمل الخلطات لإستيعاب أكبر نسبه من الإ ستبدال بدقيق البقوليات المختلفـه مـن الدقيق الضعيف) المعتاد إستخدامه فى صناعه البسكويت) فيماعدا زمن الوصول الـذى كان أقل فى خلطات البقول غير المنبته وكانت قراءات الإكستنسوجراف بالنسبه لكـل من المرونه والرقم النسبى أعلى فى كل الخلطات الناتجه بينما كانت كل من المطاطيـه وطاقه العجين أقل فى كل الخلطات الناتجه بالمقارنه بدقيق البسكويت الضعيف ممايدل على إن دقيق الخلطات أكثر ملائمة لخواص الجوده التكنولوجيه لصناعه البسكويت كما أوضحت النتائج أن كل ١٠٠جم من البسكويت المـدعم ب ٤٠% مـن دقيـق هـذه البقوليات يساهم ب(٥١,٦٨-٥٦,٢١%) من الاحتياجات اليوميه الكليه مـن البـروتين بالنسبه للاطفال وب(٢٤,٩٥-٢٧,١٤ %) بالنسبه للبالغين- وتوصى نتيجـه الدراسـه بإستخدام دقيق هذه البقوليات وخاصة المنبته فى تدعيم دقيق القمح لرفع القيمه الغذائيه فى منتجات المخابز.