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Functional Attribute of Chickpea and Defatted Soybean Flour Blends on Quality Characteristics of Shortening Cake

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Abstract: Quality attribute of shortening Cake fortified with two different levels (5 and 10%) of chickpea and soybean flour blends each individually was investigated. Physically, sensory and nutritional properties of the prepared cake samples were evaluated. Fortification with each of the two levels of soy flour and (5%) chickpea flour did not negatively affect the sensory characteristics of the final product. All products were found to be acceptable as recorded the panelist in terms of color (external/internal), appearance, texture, taste and overall acceptability. The study showed an increase in mineral composition (K, Zn and Fe) of the fortified cake samples. Moreover, there was an increase in amino acids composition of the fortified cake as compared to the unfortified samples. In addition, the high quality protein of cake fortified with each of chickpea and soybean composite flour as calculated by chemical scores was reported to be higher than that of the unfortified cake sample in almost essential amino acid. The study recommended that the technology of using composite flour should be encouraged among food industries to make economic use of local raw material and to produce high quality food products such as shortening cake particularly for the populations of developing nations.

Key words: Composite flour · Legumes · Shortening cake · Nutritive value · Sensory evaluation · Physical properties · Minerals composition · Amino acid

INTRODUCTION

Protein inadequacies are a problem facing risk population groups of the world, particularly populations in developing countries where diets consist mainly of cereals. Composite flour technology refers to the process of mixing wheat flour with cereals and legumes. Cereal-pulse combinations have been employed for the production of various products. In addition to being rich protein source, pulses are being recognized as having therapeutic/medicinal properties [1]. Most snacks are fun to eat but are low in nutritive value. If they are taken in large quantity, they can suppress the appetite for the main meal. For this reason, snack with high protein and high fiber should be developed as a supplementary diet [2]. The quality of cake depends on the quantity and quality of ingredient especially the flour used in preparation. It was found that mixing two or more of different materials will help to solve the deficiency problem of cereal as low nutritional value by used legumes as food protein source. Legumes with high protein content are widely used as composite flour in the production of cookies. Among legumes that are frequently used in cookies are cowpeas, great northern bean, faba bean, navy bean, lupine bean, chickpea, field pea and soybean [3]. In several countries, legumes have increasingly been used in dietetic formulations to prevent diabetes and cardiovascular diseases, lowering blood cholesterol levels and reducing colon cancer risk [4, 5]. Legume flours, due to their amino acid composition and fiber content are ideal ingredients for improving the nutritional value of bread and bakery products [6]. Grain legumes are a valuable source of protein (18- 25 %, dry basis) and carbohydrates (50-60%, dry basis), with starch (22-45%, dry basis) and non-starch polysaccharides (dietary fiber) as predominant fractions and a small but significant amount of oligosaccharides [7-9]. Legume starches contain about 30-40% of amylose compared to cereals, processing of legumes may lead to increase in the net resistant starch (RS) content which may have important effects on human physiology. The digestibility of

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legume starch is much lower than that of cereal starch. Diets rich in RS may have important effects on human health with some effects similar to those reported for soluble dietary fibre. The higher content of amylose in legumes, which probably lead to a higher RS content, may possibly account for their low digestibility. Legumes contain more of proteins than cereals and protein-starch interaction in legumes may equally contribute to their decrease in glycemic responses [10].

Soybean is an economically important crop, which serve as a source of good-quality protein for animals and humans. The seeds contain up to 48% protein and also contain bioactive proteins including alpha-amylase and lipoxygenase which are considered very useful for the bread making process. Moreover, the essential amino acid content in soybean exceeds the amino acid requirements of children and adults, which confirms the protein quality of this legume [11]. Also Chickpea is an important source of proteins, carbohydrates and certain minerals, particularly to the populations of developing nations. The chickpea seed contain 21.1% protein, 3.1% fat, 53.4% carbohydrate, 11.1% fiber and 5.9% ash [12].

In Egypt, chickpea seeds are usually consumed at the raw green and tender stage (unripe stage), called Malana, or in the form of mature dry seeds after parching as a popular snack food. The dry seeds can also be consumed as whole or decorticated after cooking and processing in different ways. In addition to this usage, the flour of decorticated chickpea seeds is used in several dishes and as a supplement in weaning food mixes, bread and biscuits [13, 14]. The chickpeas products contain 8.9-21.1% protein, 3.1-21.8% fat, 53.4-75.9% carbohydrate, 1.6-11.1% crude fibre, 1.2-5.9% ash, 226-360 mg Ca, 126-315 mg P, 3.8-8.2 mg Fe, 1.8-5.4 mg Zn, 1.5-5.4 mg Mn, 0.6-1.1 mg Cu and 370-490 kcal per 100 g [15-17].

The main objective of this study was to investigate the functional properties of Chickpea and Soybean composite flour on quality characteristics of shortening Cake.

MATERIALS AND METHODS

Materials: Wheat flour (72%); sugar, butter, milk, whole eggs, Chickpea seeds and baking powder were purchased from the local market. Defatted soy flour blend was purchased from Agricultural research center in Giza-Egypt.

Methods

Preparation of Chickpea Flour Blend: Chickpea seeds were soaked in distilled water for 12 h at room temperature (25°C). The soaked seeds were drained and rinsed three times with distilled water, then dried in oven (105°C). Chickpea was milled, the flour was referred as white chickpea flour; and the coarse fraction was ground again in a laboratory mill. The flour from the second milling was blended with the white chickpea flour in order to obtain the chickpea flour.

Preparation of Composed Flour: Preparation of composed flour was done by mixing wheat flour (72%) with chickpea flour and defatted soy flour each individually at two different ratios (5 and 10%). The final composed flour mixture of each type of flour was blended to ensure the homogeneity of the mixture and kept individually in polyethylene bags in refrigerator for further usage.

Preparation of Fortified Shortening Cake: Preparation of fortified shortening Cake with each of the two composed flour (5 and 10 %) of Chickpea or defatted soy flour individually was done according to Penfield and Camphell [18]. The standard formula used is presented in Table 1. The cake samples were baked at 250°C for 25 min. The cake samples were removed from the pans and left for 1 h at room temperature for cooling. The cake sample placed on coded white plastic plates and sealed with plastic wraps to prevent it from drying till further evaluation.

Quality Attributes Evaluation of the Fortified Shortening Cakes: Physical Evaluation: Water uptake (ml) during preparation and weight (g) after baking was recorded.

Table 1: Ingredients of standard cake preparation and fortified shortening cake preparation with different ratios (5 and 10%) of composed flour (Chickpea or defatted soybean flour)

		Composed flour (g) with Chickpea flour (or) defatted soybean flour	
	Standard		
Ingredients	Amount (g)	5%	10%
Flour	220	209	198
Sugar	120	120	120
Butter	125	125	125
Eggs	135	135	135
Milk	120	120	120
Baking powder	10	10	10
Vanillin	10	10	10
Salt	2	2	2

Measurement parameters were done on fresh shortening cake samples (fortified/unfortified) with regard to product's volume (cm^3), height (cm), index to volumes (cm), percentage change (%) in product weight and degree of softness (mm/sec) by penetrometer apparatus according to Penfield and Camphell [18].

Sensory Evaluation: Sensory evaluation was carried out by (10) trained panelist from department of Nutrition and Food Science-Faculty of Home Economics, Helwan university using semi-structured scales scoring (1 = lowest quality to 5 = highest quality) according to Klein [19] and Penfield and Camphell [18]. The evaluated characteristics included visual appearance, color (external/internal), cell uniformity, firmness, odor, taste and overall acceptability.

Proximate Composition: Moisture, Protein, Lipid and Fiber were determined following standard AOAC [20] and crude ash as percentage were estimated according to AACC [21]. Total carbohydrates were calculated by difference. Minerals (Iron, magnesium, sodium, calcium, potassium and zinc) were determined by atomic absorption spectrophotometer (Type Unicom-929) according to the methods of AOAC [22]. Amino acids were determined by using Eppendrof-Germany LC3000 Amino acid analyzer apparatus at the National Research Center, Dokki, Cairo [23]. Tryptophan was determined according to the method of Blauth *et al.* [24]. The amino acid scores (A.S.) were calculated using the reference protein of the FAO/WHO/UNU [25] for adult as follows: amino acid score (A.S.) = content of individual amino acid/ content of same amino acid in reference.

Statistical Analysis: The obtained results of products firmness and sensory evaluation were statistically analyzed according to statistical analysis system, SAS User's Guide [26].

RESULTS AND DISCUSSION

Selected measurements for objective evaluation of fortified shortening cake are illustrated in Table 2. It was found that water uptakes was increased (160 ml) by (40 ml) upon increasing the ratio of soybean (10%) as compared to that of the unfortified sample (120 ml). While water uptakes of dough fortified with 5% soybean had lower value than that of the unfortified dough (control). However, dough fortified with 5 or 10% chickpea showed similar values of water uptakes as the control dough. According to Nilufer [27] high level of water is necessary, because fiber has the ability to absorb water and interferes with hydration of gluten proteins unless sufficient water is added to hydrate both the fiber and the glutein. However, high level of water makes the product especially susceptible to mold growth unless an adequate amount of propionate is added as anti mold agent.

Baking time (min) showed an increase with fortified cake with Chickpea. Weight of fortified cake with different level of Chickpea and Soybean decreased as the level of fortification increased. The latest finding disagreed with Heagzy and Faheid [28] who reported that wheat flour substitution with 10% chickpea flour was possible without affecting baking and physical characteristic of cookies. Volume of fortified cake shows to increase with increasing level of soybean and with 5% of chickpea. However, the greatest cake volume was produced upon fortification with composed flour with defatted soybean flour of both levels (5 and 10%). The present of bioactive proteins including alpha-amylase and lipoxygenase in soy flour could be the reason for improving the final product volume. These results may be related to higher fiber composition of the fortified products. These results agree with Singh *et al.* [29] who reported that cake volume and specific volume significantly increased with increased level of different types of fiber. On the other hand,

Tables 2: Selected measurements for objective evaluation before and after preparation of fortified cake

		Chickpea flour		Defatted soybean flour	
Characterizes	Control	5%	10%	5%	10%
Water uptake (ml)	120	120	120	100	160
Weight before baking	700	700	700	700	700
Weight after baking	665	655	640	650	640
baking time (min)	39	54	59	30	31
Volume (cm^3)	1550	1950	1560	1790	1960
Height (cm)	7.43	7.17	5.8	7.93	7.87
Index to volume (cm)	8.36	8.30	7.26	8.98	8.90
Degree of softness (mm/sec)	268.4±7.68^a	269.8±5.198^a	276.4±8.67^b	274.2±11.06^{ab}	296.2±3.569^b

Table 3: Mean value of organoleptic scores of shortening cake (fortified/ unfortified)

Samples Characteristics	Unfortified Cake (Control)	Fortified Cake with 5 % Chickpea	Fortified Cake with 10 % Chickpea	Fortified Cake with 5 % Defatted Soybean	Fortified Cake with 10 % Soybean
Appearance	4.1±0.16[a]	4.0±0.25[a]	3.0±0.21[b]	4.3±0.15[a]	3.9±0.17[a]
Color	4.58 ±0.24[a]	4.42±0.22[a]	3.5±0.2[b]	4.5±0.16[a]	3.87±0.25[b]
Cell uniformity	4.75 ±0.18[a]	4.25±0.24[a]	3.67±0.17[b]	4.56±0.21[a]	4.33±0.20[b]
Moistness	4.7±0.17[a]	4.28±0.29[a]	3.63±0.17[b]	4.53±0.25[a]	4.43±0.18[a]
Odor	4.92±0.16[a]	4.0±0.23[b]	3.5±0.20[b]	4.17±0.26[a]	4.42±0.15[a]
Taste	4.9±0.21[a]	3.96±0.18[b]	3.08±0.15[b]	4.83±0.23[a]	4.73±0.21[a]
Overall acceptability	4.9±0.26[a]	4.12±0.29[b]	3.23±0.16[b]	4.68±0.22[a]	4.42±0.18[a]

Means with the same letter are insignificantly different (P<0.05)

the present findings disagreed with Chen *et al.* [30] who found that loaf volume and specific volume significantly are decreased with the increase in the level of fiber. The height and index of volume were decreased by increasing level of chickpea flour, while there was a little increase upon soybean fortification. Degree of softness (Tenderness) is significantly increased by increasing level of chickpea and soybean. This increase may be due to water holding capacity of fiber and its ability to retain moisture and increase degree of softness. Heagzy and Faheid [28] reported that wheat flour substitution with 10% chickpea flour was possible without affecting baking and physical characteristic of cookies. Chickpea starches contain 20-30% amylase and the remainder is amylopectin, the cooking characteristics of cake fortified with chickpea flour may be influenced by the relative proportions of amylase and amylopectin present. The availability of gelatinized starch and the amount of amylopectin and amylase affect the functionality of dough used for baked cakes. Increasing the free amylopectin content has been shown to yield softer, cohesive dough and provides film formation, sheet extensibility and better puffing when heated [31].

Sensory evaluation results of fortified cake are presented in Table 3. It was found that cake which was fortified with (10%) level chickpea and soybean flour had lower scores for color and cell uniformity. Cake fortified with defatted soybean flour at different levels had non-significant difference in taste, odour and overall acceptability as compared to unfortified cake (control). Meanwhile, fortified cake with chickpea at 10% had significant lower value (3.23±0.16) as compared to unfortified cake (4.9±0.26). In addition, the quality characteristics were acceptable at 5% for both types of decomposed flour. It is evident from this data, that addition of chickpea more than 5% caused gradually decreased in sensory characteristics scores. The results showed that addition of soy-flour blend at 5% and 10% levels to wheat flour had no adverse effect on sensory attributes of the final product. From the above results, it can be concluded that shortening cake can be fortified with chickpea (5%) and soybean (5 and 10%). The present results came in agreement with Dimitrios *et al.* [12] who reported that, organoleptic properties (colour, flavour and overall acceptability) improved with a low proportion of chickpea flour, especially for 5% w/w substitution. Guadagni and Delpha [32] and Alabi and Anuonye [33] indicated that up to 50% of some legume products could be added without significant loss in palatability.

The proximate composition of fortified cake with the two levels (5 and 10%) of chickpea and soybean flours as compared to the control values represented as (%) is illustrated in Table 4. It was found that cake fortified with 10% and 5% of defatted soybean flour contained high values of protein (11.82% and 10.29%, respectively), followed by chickpea (9.74 and 9.51%, respectively), as compared to control values (9.42%). The cake fortified with chickpea flours had higher content of fiber, moisture content and carbohydrates, than that of wheat cake and followed by cake fortified with soybean. However, it showed lower values of lipids content (13.00 and 13.41%). Whereas ash content were higher in samples fortified with10% of soybean (2.42%) as compared with the control (2.09%). These results came in agreement with Alabi and Anuonye [33] and Shahzadi *et al.* [1] who reported that legumes with high protein content are widely used as composite flour in the production of bakery products, the protein content and quality of cake can be improved by substituting cereal with legume as composite flour.

Meanwhile unfortified cake samples had higher contents of Sodium (Na), Calcium (Ca) and Magnesium (Mg). On the other hand, the fortified cake samples with (5% and 10%) soybean and chickpea flours contained high values of K (191.79%; 265.71% and 140.76%; 141.78%, respectively) Zn (10.0%; 49.26% and 10.0%;

Table 4: Effect of fortification with soybean or chickpea composed flour on proximate composition and minerals of shortening cake

Proximal composition %	Control	Defatted Soybean flour 5%	Defatted Soybean flour 10%	Chickpea flour 5%	Chickpea flour 10%
Protein	9.42	10.29	11.82	9.51	9.74
Carbohydrate	45.25	48.51	40.51	47.24	44.05
Fiber	1.48	1.40	2.10	3.34	3.51
Lipids	14.26	13.92	16.43	13.00	13.41
Moisture	27.50	23.77	26.72	24.98	27.16
Ash	2.09	2.11	2.42	1.93	2.13
Minerals (mg / 100 gm)					
Na	391.60	333.75	391.60	342.65	369.35
Ca	99.00	78.00	97.00	79.00	81.00
Mg	18.00	9.00	11.00	8.00	11.00
K	132.09	191.79	265.71	140.76	141.78
Zn	1.00	10.00	49.26	10.00	24.75
Fe	1.00	6.98	7.88	7.14	7.43

Table 5: Amino acid composition (gm/16 gm N) and chemical scores (A.S) of control and fortified cake with 5% of Chickpea or Soybean

		Control		5% Chickpea flour		5% Defatted Soybean flour	
Amino Acids	FAO/WHO/ UNU Reference Protein	gm/16gm N	A.S.	gm/16gm N	A.S	gm/16gm N	A.S.
Aspartic	-	8.95	-	9.12	-	9.24	-
Threonine	0.9	2.76	2.76	3.19	3.54	3.42	3.8
Serine	-	6.65	-	6.60	-	6.61	-
Glutamic	-	18.87	-	18.67	-	18.83	-
Glycine	-	3.89	-	3.91	-	3.95	-
Cystine	-	2.56	-	2.75	-	2.63	-
Methionine	-	2.13	-	2.08	-	2.12	-
Isoleucine	1.3	7.28	5.60	7.37	5.67	7.41	5.70
Leucine	1.9	5.12	2.69	5.49	2.89	5.51	2.90
Tyrosine	-	5.56	-	4.33	-	4.41	-
Phenylalanine	-	5.79	-	5.57	-	5.55	-
Histidine	1.6	3.53	2.21	3.43	2.14	3.65	2.28
Lysine	1.6	3.24	2.03	3.54	2.21	3.34	2.09
Arginine	-	5.67	-	5.89	-	6.13	-
Valine	1.3	4.56	3.51	4.53	3.49	4.96	3.82
Alanine	-	4.04	-	4.98	-	4.03	-
Tryptophan	0.5	1.23	2.46	1.39	2.78	1.41	2.82
Proline	-	8.17	-	8.03	-	8.08	-
Phenylalanine+ Tyrosine	1.9	11.35	5.97	9.90	5.21	9.96	5.24
Methionine+ Cystine	1.7	4.69	2.76	4.83	2.61	4.70	2.77

24.75%, respectively) and Fe (6.98%; 7.88% and 7.14%; 7.43%, respectively) as compared to control (K132.09%, Zn 1.0% and Fe 1.0%). The results of the present study showed that the nutritional quality of shortening cake especially with regard to fiber, Zn and Fe composition was enhanced upon fortification with each of the composed flour from these two sources (Chickpea and Soybean blended flour) particularly to the populations of developing nations.

The amino acid composition of unfortified and fortified cake with 5% of soybean or chickpea (as gm/16 gm N) is shown in Table 5. The nutritional quality of a protein is dependent upon many factors among which is the effectiveness of the test protein in meeting the amino acid requirements of a particular function and the degree of retention of the component amino acids during processing and essential amino acid (EAA) composition of the test protein compared to the FAO reference protein values [25]. From the present results it can be observed that, almost total amino acids were higher in fortified shortening cake than that of the unfortified cake. Also, the high quality protein of both types of composed flour fortification were confirmed by calculating chemical scores which were found to be higher than the control value (unfortified cake) in almost all essential amino acid. These results came in agreement with FAO/WHO

reference [34]. The protein quality of soybean and chickpea were rich in essential amino acids (isoleucine, lysine, total aromatic amino acids and tryptophan) compared with the reference pattern while cereals such as wheat are low in (lysine and total protein content) as stated by Patel and Rao [3]. However, leucine, total sulfur amino acids, threonine and valine were slightly deficient in chickpea protein, also soybean protein are deficient in some essential amino acids (methionine and cystine) compared with the reference pattern. Therefore, from the previous data, soybean and chickpea protein could very well complement those protein sources that are low in lysine and tryptophan as reported by Shahzadi *et al.* [1] and Alabi and Anuonye [33]. It is apparent that composite flour prepared by blending wheat and legumes in proper proportions can provide the required amino acids to the consumer.

CONCLUSION

From the present investigated work, it can be concluded that replacement of wheat flour with defatted soybean up to 5-10% and chickpea at 5% can be followed without any adverse effect on physical and sensory characteristics of shortening cake. Soybean and chickpea flours supplementation significantly caused improvement in cake's composition of fiber, mineral (Zn and Fe), protein and amino acid scores. It can be recommended that the technology of using composite flour should be encouraged among food industries to make economic use of local raw material and to produce high quality food products such as shortening cake particularly for the populations of developing nations.

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