Production of high nutritive value and physical and sensory characteristic wheat biscuits fortified with chick pea flour

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Abstract: Chick pea is reckoned as a valuable nutritional healthful functional food. The present investigation was performed to assess nutritional status of wheat biscuits and chick pea flour fortified wheat biscuits. Study included determination of gross chemical composition, caloric value, minerals (Mn, Ca, Fe, Cu, P, Na and K), vitamins (C, Folic acid, A, and E), and amino acid composition of wheat biscuits and 15%, 25% chick pea flour fortified wheat biscuits. Likewise, physical and sensory characteristics of studied biscuits were assessed. The data revealed that 25% chick pea flour fortified wheat biscuits proved to be nutritious functional healthful food. It improved both physical, sensory characteristics and increased protein and ash contents, but decreased fat, carbohydrates and caloric value. While, it recorded an increment in the all seven studied minerals as well as increased all the studied four vitamins, and the amino acids isoleucine, leucine, lysine, threonine, and valine contents resulting in an improvement of the nutritive value of 25% chick pea flour fortified wheat biscuits. Therefore it could be recommended for caloric reduced diets for diabetic, obese, and overweight persons, as well as for school students diets. Beside, it should be used as an ingredient in the bakery industry, i.e. in biscuits, bread, snack foods, breakfast foods, and cakes.
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1. Introduction:

Chick pea is considered as a valuable healthful functional food. Chick pea, due to its high protein, minerals, vitamins, amino acid composition and fiber content is an ideal ingredient for improving the nutritional value of biscuits and bakery products (Hefnawy *et al*., 2012). Chick pea is suggested to improve infant food and nutrition in developed countries (Sotelo *et al.,* 1987c; Ulloa *et al*., 1988; and Alarcon and Valdez (2005). Chick pea is the fifth widely grown legume in the world (Varela *et al*., 1995).

Supplementation of wheat flour with chick pea would significantly enhance the protein quality of the product (Hernandez and Sotelo, 1984). The crude protein content of chick pea seeds ranged from 15-30% and it is considered one of the best nutritional quality in the legume family (Chavan *et al*., 1987). Chick pea flour can be used to enrich cereal flours without impairing flavor, baking quality (Hernandez and Sotelo (1987). Abdel-Hamid *et al*. (2002) studied the effect of 5%, 10% and 15% chick pea fortification of the wheat flour 72% bread on the proximate chemical composition and the baking properties of the rusk.

In addition to being an important source of protein, chick pea is also reported to be a good source of minerals (Nestures *et al*., 1997). It supplies consumers with larger amounts of calcium and phosphorus than does other legumes (Mataix *et al*., 1995; and Teresa *et al*., 1999).

Dodok *et al*. (1993) stated that bread and biscuits containing 10-20% chick pea meal had acceptable quality and higher nutritional value than those made from wheat flour alone. The amino acid composition of chick pea was assessed by Fiorenteni *et al*. (1981), Sotelo and Adsule (1996), Youssef (2003), Alarcon-Valdez *et al*. (2005) and Noor *et al*. (2012).

Furthermore, chick pea is considered of good source of vitamins (Dodok *et al*., 1993).

Chick pea adjusts blood glucose content in diabetic patients since it affects the relative glycemic response (Hawkins and Johnson, 2005).

The fortification of the bakery products and bakers confectionery with chick pea, i.e. bread and toast bread, cookies, snak foods, biscuits and infant foods were reported by several authors, i.e., Hefnawy *et al*. (2012); Noor *et al*. (2012); Yamsaengsung *et al*. (2012), Chanchal *et al*. (2013); Hassan *et al*. (2013) and Baljeet *et al*. (2014).

This investigation was designed to produce fortified wheat biscuits, which has better nutritional value, available and relatively cheap and does not require any preparation efforts before use. The objectives of this investigation was to study the gross chemical composition, caloric value, the mineral composition, the vitamin composition, the amino acid composition, as well as physical and sensory quality

attributes of wheat biscuits and chick pea fortified biscuits.

2. Material and Methods:

2.1. Materials:

Five kg wheat flour 72% extraction hard red winter were obtained from El-Haram Milling Company, Faisal, Giza in November 2014. Chick pea (5 kg), sugar powder, powdered milk, butter, sodium chloride, ammonium bicarbonate, sodium bicarbonate and baking powder were purchased from Cairo local market in November 2014.

Chick pea was milled in the laboratory and both wheat flour and chick pea flour were kept in glass containers at 4°C in the refrigerator till the analysis.

2.2. Technological process:

Control biscuit dough was prepared according to the formula presented in Table (1), Rao and Manohar (1999). The supplemented biscuits with chick pea were prepared using the same formula except for replacing the wheat flour with 15% and 25% of chick pea flour.

Table (1): Wheat flour biscuits formula*.

Ingredients	Gram
Wheat flour (72% extraction rate)	100.00
Powdered sugar	20.00
Sodium chloride	0.50
Powdered milk	10.00
Butter	40.00
Ammonium bicarbonate	1.00
Sodium bicarbonate	0.50
Baking powder	0.50
Water	25.00

* Rao and Manohar (1999).

2.2.2. Dough preparation:

Powdered sugar and butter were creamed in Braun Mixer with a flat beater for 2 minutes at 5 rpm. Water containing sodium chloride, ammonium bicarbonate, powdered milk, sodium bicarbonate and baking powder were added to the cream and mixed for 5 minutes at 125 rpm to obtain a homogenous cream. Thereafter the flour was added slowly to the above cream and was mixed for 2 minutes at 60 rpm to obtain biscuit dough (Saba, 1997).

2.2.3. Preparation of biscuits:

The dough was sheeted to thickness of about 3 mm using Atlas Brand Rolling Machine. The sheeted dough was cut into round shape using a 45 mm diameter cutter and baked on an alluminium tray in an electric oven at 180°C for 6 minutes. The biscuit was cooled for 30 minutes, packed in polyethylene bags stored under desiccation (Vatsala and Hardias Rao, 1991, and Manohar and Rao, 1997).

2.2.4. Preparation of different blends of biscuits:

Blends of biscuits were prepared using wheat flour 72% extraction rate as control or those which were substituted with 15% and 25% chick pea flour.

3. Methods:

3.1- Physical evaluation of biscuits:

Biscuit were evaluated for height (cm), width (cm), spread ratio and spread factor. Five biscuits were used for the evaluations from the three studied biscuits and averages were recorded. The spread ratio and spread factor were evaluated according to Manohar and Rao (1997) using the following equations:

$$Spread\ ratio = \frac{Width}{Height}$$

$$Spread\ \ factor = \frac{Spread\ ratio\ of\ sample}{Spread\ ratio\ of\ control} x100.$$

3.2. Sensory evaluation of biscuits:

Sensory evaluation for the color, texture, taste, odor, and overall acceptability were done in order to determine consumer acceptability. A numerical hedonic scale ranging from 1 to 10 (1 is very bad and 10 for excellent) was used for sensory evaluation (Larmond, 1977). Ten experienced judges participated in the test.

3.3. Gross chemical composition:

Moisture, protein, fat, crude fiber and ash were determined according to the Methods described in A.O.A.C. (2010). Total carbohydrates content was calculated by difference (100 – total gross chemical composition) on dry weight basis according to A.O.A.C. (2010). The caloric value was calculated according to the method of Sleet (2010).

3.4. Mineral composition:

Total content of elements was carried out using a mixture of ($HClO_4$/ HNO_3) according to inductive Coupled Plasma Emission Spectrometry. The elements Ca, Mn, Cu and Fe were determined using ICP (ICAP 6200) according to Isaac and Johnson (2002).

Sodium and potassium contents were estimated using Flame Photometry (Jenway PFP7) according to the procedure reported by A.O.A.C. (2005). Phosphorus was estimated using GBC Atomic

Absorption 906 A according to the procedure described in A.O.A.C. (2012).

3.5. Vitamins assay:

Vitamin C was determined using Aglient HPLC (UV-vis) as described by Odriozola-Serrano *et al*. (2007). Folic acid was determined using Surveyour HPLC (PDA) as described by Albala-Hurtado *et al*. (1997). Vitamins A and E were determined using Schmidzua HPLC (PDA) as described by Gomis *et al*. (2000).

3.6. Amino acids composition:

Acid hydrolysis was carried out according to the method of Baxter (1996). The dried and defatted grinding sample (Ca. 0.2 g) was hydrolyzed with 6N HCl (10 ml) in sealed tube, heated in an oven at 110°C for 24 hours. The resulting solution was completed to 25 ml with de-ionized water. After filtration, 5 ml of hydrolyzate was evaporated until to be free from HCl vapor. Then the residue was dissolved in diluting citrate buffer (pH 2.2). The system used for the analysis was High Performance Amino Acid Analyzer, Model: Ingos AAA 400.

3.7. Tryptophan determination:

Tryptophan was determined by the colormetric method using UV-160 IPC, Shimadzu. UV-Visible spectrophotometer (550 µm) according to the method described by Sastry and Tammuru (1995).

4. Results and Discussion:

4.1. Physical characteristics of biscuits:

Chick pea flour had been considered as a functional food supplement in several bakery products. The mean values of physical characteristics of wheat biscuits and fortified wheat biscuits with 15% and 25% chick pea flour are presented in Table (2) and Figures 1-3.

The data recorded an equal increment (10.3) of both 15% and 25% chick pea flour fortified wheat biscuits for the spread ratio. Considering the spread factor of control biscuits (100% wheat flour 72% extraction ratio biscuits) as 100, results given in Table (2) indicated that it increased to 150 for 15% and 25% chick pea flour fortified wheat biscuits. The data agree with Rababah *et al*. (2006), Yamsaengsung *et al*. (2012) and Baljeet *et al*. (2014).

Table (2): Physical characteristics of 100% wheat flour 72% extraction biscuits (control) and wheat flour biscuits supplemented with 15% and 25% chick pea flour.

Biscuit samples	Width[a] (cm)	Thickness[b] (cm)	Spread ratio[c]	Spread factor[d]
100% wheat flour 72% extraction biscuits (control)	5.5	0.8	6.8	100
15% fortified wheat biscuits with chick pea flour	6.2	0.6	10.3	150
25% fortified wheat biscuits with chick pea flour	6.2	0.6	10.3	150

a Width of 5 biscuits in series. b Thickness of 5 biscuits in series.

c Width/thickness. d $\frac{Spread\ ratio\ of\ sample}{Spread\ ratio\ of\ control} x100.$

4.2. Sensory characteristics of biscuits:

The sensory characteristics of the studied wheat biscuits as influenced of incorporation of 15% and 25% chick pea flour are outlined in Table (3). The data revealed that both fortified wheat biscuits with 15% and 25% chick pea flour improved all studied sensory characteristics. Such data are in good agreement with Noor *et al*. (2012), Hassan *et al*. (2013) ande Chanchal *et al*. (2013).

Table (3): Sensory characteristics of 100% wheat flour extraction 72% biscuits (control) and wheat flour biscuits supplemented with 15% and 25% chick pea flour*.

Biscuits samples	Color	Texture	Taste	Odor	Overall acceptability
100% wheat flour biscuits extraction biscuits (control)	8.00	8.00	7.8	8.00	8.00
15% fortified wheat biscuits with chick pea flour	8.20	7.9	7.6	8.20	8.20
25% fortified wheat biscuits with chick pea flour	8.30	7.9	7.6	8.30	8.20

* Mean of ten replicates.

Fig. 1. 100% wheat flour-72% extraction biscuits.

Fig. 2. 15% chick pea fortified wheat biscuits.

Fig. 3. 25% chick pea fortified wheat biscuits.

4.3. Gross chemical composition of biscuits:

The mean value of gross chemical composition and caloric value of wheat biscuits and fortified wheat biscuits with 15% and 25% chick pea are given in Table (4). The data revealed that incorporation of 15% chick pea flour in wheat flour biscuits increased protein content, but decreased fat, crude fiber, carbohydrates and caloric values. However, 25% chick pea flour supplementation wheat biscuits increased ash, and protein, but decreased fat, carbohydrates and caloric values. Such data are in good accordance with Noor *et al*. (2012), Marcaferri *et al*. (2012), Hassan *et al*. (2013) and Baljeet *et al*. (2014).

Table (4): Gross chemical composition and caloric value of wheat flour 7% biscuits and 15% and 25% chick pea flour fortified wheat biscuits (on dry weight basis) *.

Biscuit's samples	Moist-ure	Ash	Protein	Fat	Crude fiber	Total carbo-hydrates	Caloric value Kc/100g
Wheat flour biscuits 72% extraction (control)	9.50	0.97	9.11	18.97	2.00	68.85	482.57
15% chick pea fortified wheat flour biscuits	18.42	0.97	13.52	17.00	1.00	67.51	468.12
25% chick pea fortified wheat flour biscuits	14.50	2.94	14.01	18.65	2.00	62.40	473.49

* Mean of three replicates.

4.4. Minerals composition of biscuits:

The mean values of minerals composition of wheat biscuits and 15% and 25% chick pea fortified wheat biscuits are outlined in Table (5). The data revealed that both 15% and 25% chick pea flour fortified wheat biscuits increased all the seven studied minerals, i.e. Mn, Ca, Fe, Cu, P, Na and K contents. Such data coincide with Avancini *et al*. (1992), Dodok *et al*. (1993) and Romero-Baranzini *et al*. (1995).

Table (5): Mineral content of wheat flour 72% biscuits and 15% and 25% chick pea flour fortified wheat flour biscuits (on dry weight basis)*.

Biscuits samples	Mn mg/kg	Ca mg/kg	Fe mg/kg	Cu mg/kg	P mg/kg	Na mg/kg	K mg/kg
Wheat flour 72% biscuits (control)	6.29	1449	151.20	3.19	955.35	3781	1182
15% chick pea flour fortified wheat biscuits	11.07	2316	161.83	5.62	1907.81	4955	6324
25% chick pea flour fortified wheat biscuits	13.47	2290	173.26	3.48	1751.15	4640	7324

* Mean of three replicates.

4.5. Vitamins content of biscuits:

The data outlined in Table (6) represented the mean values of vitamins content in wheat biscuits and 15% and 25% chick pea flour wheat biscuits. The data revealed that 15% chick pea flour fortified wheat biscuits increased folic acid and vitamin E contents, while, 25% chick pea flour increased vitamin C, folic acid, and vitamins A and E contents. Such data are in agreement with Dodok *et al*. (1993), Kiran *et al*. (2003), and Hefnawy *et al*. (2012).

Table (6): Vitamin content of wheat flour 72% biscuits and 15% and 25% chick pea flour fortified wheat biscuits (on dry weight basis)*.

Biscuit samples	Vitamin C mg/100g	Folic acid mg/100g	Vitamin A mg/100g	Vitamin E mg/100g
Wheat flour 72% biscuits (control)	2.90	0.027	1364	1.60
15% chick pea flour fortified wheat biscuits	2.80	0.352	1034.3	2.30
25% chick pea flour fortified wheat biscuits	9.20	0.376	6139.2	10.6

* Mean of three replicates.

4.6. Amino acid content of biscuits:

The amino acid composition data of wheat biscuits and 15% and 25% chick pea flour fortified wheat biscuits are presented in Table (7). The outlined data revealed that both 15% and 25% chick pea flour fortified wheat biscuits raised all the essential amino acids, except phenylalanine and tryptophan contents, resulting in improving the nutritive value of wheat biscuits. The data are in good accordance with Kovalev and Usmanova (1983), Youssef *et al*. (2003), and Alarcon-Valdez *et al*. (2005).

Table (7): Amino acid composition of wheat flour 72% biscuits and 15% and 25% chick pea flour fortified wheat flour biscuits g/100 g protein (on dry weight basis).

Biscuit samples	Isoleucine	Leucine	Lysine	Methionine	Phenyl-alanine	Threonine	Tryptophan	Valine
Wheat flour 72% biscuits (control)	0.32	4.82	1.58	1.27	5.66	0.63	1.39	3.52
15% chick pea flour fortified wheat biscuits	0.65	6.04	2.32	0.51	1.35	0.85	0.12	3.21
25% chick pea flour fortified wheat biscuits	0.91	5.95	2.03	0.80	2.25	0.96	0.20	3.88

Conclusion:

In conclusion 25% chick pea flour fortified wheat biscuits proved to be nutritious functional and healthful food. It could be recommended for caloric reduced for diabetic, obese and overweight persons, as well as for school children nutrition. Likewise, it should be used as an ingredient in the bakery industry such as functional food and healthy foods formulations as biscuits, snack foods, bread, breakfast food, and cakes.

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