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Characteristics of thick kmaj bread enrichment with faba bean (*Vicia faba*) flour

R.Y. Ajo

Al-Balqa' Applied University, Al-Huson University College, P.O. Box 50, Al-Huson 21510, Jordan; radwanajo@yahoo.com

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RESEARCH PAPER

Abstract

Thick kmaj is a flat bread type known in the west as pita bread that promotes the use of composite flour from inexpensive sources with high protein content to substitute wheat flour to produce protein-enriched bread. The effect of replacing 5, 10 and 15% of wheat flour (WF) with faba bean flour (FBF) in thick kmaj bread was evaluated compared to bread produced from wheat flour (WFB). The breads produced were evaluated using straight dough method. Proximate chemical evaluation of WF and FBF and breads showed that protein, fat and crude fibre content were increased with increasing FBF. The corresponding bread protein content increased significantly from 12.89% in WFB to 19.69% in 15% FBF bread, while bread fat content increased from 1.06% to 1.23%. The upper layer percentage was higher in bread with 15% FBF compared to the control. Sensory analysis results showed that the total score of bread was significantly higher in control and the 5% FBF replacement. The thick kmaj bread produced from composite flour 5% and 10% of FBF did not affect the sensory acceptability whereas all breads produced from composite flour improved nutritionally.

Keywords: bread quality, composite flour, faba bean, kmaj bread

1. Introduction

Cereals in general, and wheat, in particular, are principal foods in both developed and developing countries. They provide more nutrients than any other single food source but are considered nutritionally poor due to a lower protein quality. Legumes are richer with protein than cereals and are also generally better sources of essential amino acids, particularly lysine. Although, cereals are lysine-deficient, they are relatively better sources of sulphur-containing amino acids, such as methionine (Duodu and Minnaar, 2011). The benefits of producing cereal-legume composite foods may be considered as twofold: (1) there is an overall increase in the protein content of the composite food; and (2) there is a better amino acid balance due to the contribution of lysine by legumes and the contribution of methionine by cereals (Duodu and Minnaar, 2011).

Flat bread is a major form of wheat consumption and a staple food in many North Africa and Middle Eastern countries (Jooyandeh, 2009), particularly in Jordan (Amr and Ajo, 2005). The essential ingredients of flat Arabic bread are the same for all other types of bread; they consist of flour, water, salt, yeast (Amr, 1988) and sugar which is called the lean formula (Paulley *et al.*, 1998). Since flat bread is widely consumed, it is an excellent vehicle for furnishing protein in the diet to develop nutritionally balanced and organoleptically attractive basic protein bread from alternative food sources. In terms of quality, the baking products to be prepared from such mixtures should, if possible, be comparable to similar products made from wheat. For these flour mixtures, the FAO has coined the name composite flours (Olaoye and Ade-Omowaye, 2011).

A lot of effort has been made and still being made to promote the use of composite flours in which flour from inexpensive source and high protein seeds replace a portion of wheat flour for use in bread production, thereby decreasing the demand for imported wheat and producing protein-enriched bread (Abdul-Hussain *et al.*, 2010; Giami *et al.*, 2004; Olaoye *et al.*, 2006).

Cereal legume composite foods affect not only nutritional quality but also functional, sensory, and phytochemical qualities of final food products. Various factors play a role, including pre-processing steps followed in the preparation of the flours, the ratio of cereal to legume flours used, as well as the procedures used during the preparation of the end product (Duodu and Minnaar, 2011).

Thick kmaj flat bread type, is the typical pocket forming bread known in the west as pita or white arabic bread. A thinner and larger version of this bread can be produced by reducing the clearance between the sheeting rolls. The resulting bread, known as thin kmaj is common in the urban areas of some countries, and a long with the thick kmaj is used for sandwich preparation and spooning foods (Al-Dmoor, 2012; Qarooni *et al.*, 1992).

Numerous studies have been conducted on bread supplemented with protein rich product for inexpensive plant sources (e.g. Bojňanská *et al.*, 2012; Shahzadi *et al.*, 2005; Yamsaengsung *et al.*, 2010) thus to meet the daily requirements of people in countries where bread is a staple food.

The present work was carried out to supplement the wheat flour of thick kmaj bread with non-wheat proteins including faba bean flour at different levels and to evaluate the effect of adding this composite flour on the quality of characteristics of the produced thick kmaj bread.

2. Materials and methods

Flour samples

Straight grade (Muwahad) wheat flour was obtained from Modern Flour Mills and Macaroni Factories (Amman, Jordan) with an extraction rate from 77 to 80% according to the Jordan Institution of Standards and Metrology (JISM, 2005). Cracked, shelled faba beans (*Vicia faba*) were obtained from the local market, then cleaned and milled by Europe Mill (Denmark) and sieved to get the faba bean flour. Different composite flours were prepared by mixing wheat flour (WF), with faba bean flour (FBF) at levels of 5, 10 and 15% on wheat flour basis and were designated as A, B, C, respectively. All other ingredients where used in preparation of the bread were obtained from local markets.

Chemical analysis

Moisture, protein, lipids, fibre and ash contents were determined following (AOAC, 1997). Carbohydrate content was calculated by difference. Falling number was determined following the American Association of Cereal Chemists method (AACC, 2000). Wet gluten, dry gluten and gluten index were determined following the International Association for Cereal Science and Technology method (ICC, 1994)

Rheological properties

Water absorption, arrival time, dough development time and dough stability time were determined by the Brabender Farinograph according to the AACC approved methods (AACC, 2000).

Thick kmaj bread preparation

Bread was prepared from flour samples WF, A, B, and C using a straight dough method (Qarooni *et al.*, 1992) at a local hearth oven bakery in Al Huson, Jordan.

The bread ingredients were flour, salt (1.5%), compressed yeast (2.0%), sugar (2%) and water (57%). The dough was mixed for 5 min and then left to ferment for first proofing for 30 min, then sheeted manually for 2 to 3 min into 1 cm thick loaves. The loaves were left for a second proofing stage for 15 min and then baked at 415 °C for 1 to 2 min. The loaves were then cooled for 1 h, weighed and the loaf volume was measured by the sesame seed displacement method (Amr, 1988). Loaves upper layer weights were also measured. The results were obtained for 5 replicates and the average was calculated.

Evaluation of thick flat bread quality

Specific volume of the bread (cc/g) was defined as the quotient between loaf volume and loaf weight.

Upper layer percentage (ULP), a characteristic of thick kmaj bread which has an upper layer that resembles the crust in pan bread, was determined by separating the upper layer and weighing, then dividing it by the weight of the whole loaf according to the following formula (Amr and Ajo, 2005):

$$\mathrm{ULP} = \frac{\text{upper layer weight}}{\text{loaf weight}} \times 100$$

Trained sensory evaluation

All thick kmaj bread samples were evaluated within 1 h of baking by 10 trained panellists. They were asked to rate the bread samples from 1 to 5 for most parameters and from 1 to 10 or 15 for other parameters. The panellist judgment involved several sensory parameters, which include crust colour, spots, cracks, crispness, crumb colour, evenness of cells, smoothness, shine and sheen, ease of chewing, pocket formation, flour lumps, rolling and folding. On the second day, the panellists judged the pocket formation, ease of chewing, and rolling and folding. The evaluation was carried out at room temperature (about 25 °C) and drinking water was provided for mouth washing. The bread scoring sheet for quality characteristics was adapted from Quail (1996) and Amr and Ajo (2005). The overall quality of the bread was calculated by adding all scores together.

Statistical analysis

The data were analysed using the Statistical Analysis System (SAS, 2002). A one way analysis of variance (ANOVA) test was performed to test differences between the treatments followed by mean separation using least significant difference (LSD) analysis. Findings with a *P*-value ≤0.05 were considered to be statically significant.

3. Results and discussion

The chemical composition of FBF, WF and composite flour at different levels of replacements with 5%, 10% and 15% FBF that were used in the production of thick flat bread are shown in Table 1. The moisture content of all samples ranged from (11.37 to 11.88%). The ash content increased with increasing FBF replacement in the composite flour due to high ash content of FBF (3.47%). The protein content of the composite flour was observed to increase with increasing FBF levels due to a high protein content of FBF (29.12%). And the results of fat percentage and crude fibre behaved on the same pattern but inversely with carbohydrate percentage.

The gluten quantity (wet and dry), gluten quality (gluten index) and falling number are presented in Table 2. Incorporation of FBF in WF gave wet gluten ranging from 24.81 to 29.98% compared to 30.09% for WF (control). It was noted that increasing levels of FBF significantly ($P \leq 0.05$) decreased the dry and wet gluten except at 5% FBF. The gluten index indicates whether the gluten present in the sample is weak, normal or strong. The results obtained as replacement with FBF increased showed that the gluten index was significantly reduced ($P \leq 0.05$). Ćurić *et al.* (2001) reported that flours with a gluten index exceeding 95 are too strong and those with the index value less than 60 are too weak for bread production. The WF and composite flours with FB were within the normal gluten index range and so suitable for bread production. The falling number value of the WF was found to be 400 sec. However, it increased with increasing level of replacement with FBF. These results agree with those obtained by Hassan *et al.* (2011).

The effects of replacing wheat flour with FBF at 0, 5, 10 or 15% levels on the farinograph test are illustrated in Table 3. It was noted that the water absorption increased with increasing level of FBF. The water absorption was increased from 58.8% for WF to reach 67.3% with 15% FBF this result was compatible with some other findings (Bojňanská *et al.*, 2012; Cauvain and Young, 2000; Eissa *et al.*,2007; Shahzadi *et al.*, 2005).

Table 1. Chemical composition of faba bean flour and wheat flour.[1]

Sample	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Crude fibre (%)	Carbohydrate (%)[2]
FBF	11.76±0.55	3.47±0.12	29.12±1.34	1.68±0.16	3.90±0.91	50.06
WF	11.52±0.67	0.75±0.02	12.50±1.16	0.99±0.12	0.52±0.02	73.72
WF + 5% FBF	11.54±0.32	0.93±0.12	17.91±1.44	1.17±0.23	0.69±0.01	67.76
WF + 10% FBF	11.37±0.41	0.97±0.15	18.22±2.20	1.23±0.14	0.93±0.10	67.28
WF + 15% FBF	11.88±0.53	1.18±0.25	19.87±1.55	1.35±0.11	1.20±0.05	63.90

[1] Data presented as means ± standard deviation of 3 determinations.
[2] Carbohydrate = 100 - (moisture + ash + protein + fat + crude fibre).
FBF = faba bean flour; WF = wheat flour.

Table 2. Gluten (wet and dry), gluten index and falling number of wheat flour and composite flour.[1]

Sample	Wet gluten (%)	Dry gluten (%)	Gluten index	Falling number (sec)
WF	30.09±2.05^{a}	9.65±0.80^{a}	88.00±3.01^{a}	400±4.28^{a}
WF + 5% FBF	29.98±1.37^{a}	9.30±0.92^{a}	80.00±2.58^{b}	434±5.23^{b}
WF + 10% FBF	26.56±1.84^{b}	8.15±0.1.3^{b}	75.37±3.22^{c}	456±2.47^{c}
WF + 15% FBF	24.81±1.55^{c}	8.10±1.30^{c}	73.20±2.89^{d}	482±3.42^{d}

[1] Data presented as means ± standard deviation of 3 determinations.
FBF = faba bean flour; WF = wheat flour.
Values with different superscript letters in the same column are significantly different ($P \leq 0.05$) according to the least significant difference test.

Table 3. Rheological properties of wheat flour and composite flour.

Sample	Water absorption (%)	Arrival time (min)	Peak time (min)	Dough stability time (min)
WF	58.8	2	2.5	20
WF + 5% FBF	60	2.4	2.7	21
WF + 10% FBF	63.5	2.6	2.9	22
WF + 15% FBF	67.3	3	3.2	19

FBF = faba bean flour; WF = wheat flour.

Arrival time and peak time of WF were 2 and 2.5 min, respectively, while the level of FBF in the composite flour gradually increased, which confirms results obtained by Abdel-Kader (2000) and Kailasapathy and MacNeil (1985). However, the dough stability time of WF was 20 min and this was increased with increased level of 5 and 10% FBF, then reduced slightly in 15% FBF. These results are similar to those obtained by Shahzdi *et al.* (2005) and Abdel-Kader (2000). The decrease in stability might be due to the decrease in wheat gluten content with increasing level of replacement (Bojňanská *et al.*, 2012).

The proximate analysis of the bread prepared from wheat flour as a control and that prepared from different levels of faba bean flour replacement are presented in Table 4. The moisture content of WFB was significantly higher ($P \leq 0.05$) than the composite flour breads, while the 15% FBF composite flour bread was significantly lower than all other composite flour breads. These results were expected and consistent with other work (Abdul-Hussain *et al.*, 2010). Ash, fat and fibre contents of Kmaj bread were significantly different among bread samples; the highest value of ash, fat and fibre was in the bread prepared from 15% FBF composite flour and their values were 2.55, 1.23 and 1.00%, respectively. The protein content of bread was significantly increased by increasing the level of FBF replacements due to high protein content of FBF which was about three times of the protein content in WF. For the carbohydrate content of thick kmaj bread, it is noticed that WFB bread contained a higher value than the other types of bread.

The physical characteristics of thick kmaj bread are shown in Table 5. It was noticed that the volume of bread made from composite flours was significantly ($P \leq 0.05$) lower than those made from WF, while the weight of thick kmaj was higher in bread made with FBF. The specific volume of the bread made from WF (control) was the highest (1.60 cc/g), however, bread made from FBF was the lowest in terms of specific volume but with no significance among them. Results show that the specific volume of bread produced from 15% FBF replacement gave the lowest value (0.90 cc/g) and those results are consistent with findings of Abdul-Hussain *et al.* (2010) who indicated that the incorporation of chickpea flour decreased the bread specific volume of flat bread. Also, Hassan *et al.* (2011) reported that the addition of pigeon pea flour reduced the specific volume of bread, and recently, Bojňanská *et al.* (2012) concluded that the higher addition of lentil and chickpea worsened the quality parameters of baked bread loaves, mainly their volume. Amr and Ajo (2005) and Bojňanská *et al.* (2012) reported that there are many reasons that affect the specific volume of the bread which include proofing condition, gluten content and bread water content.

The ULP was used as an indicator of the crumb distribution. It is desirable to have less crumb attached to the upper than the lower layer in the thick bread type (Amr and Ajo, 2005). The ULP was significant in 15% FBF and WFB bread as it is shown in Table 5. As the level of FBF flour increased the ULP increased to more than 50% but still significantly lower than WF bread. The results indicate the desirable effect of adding FBF to wheat flour in thick kmaj bread making and are compatible with Abdul-Hussain *et al.* (2010) and Abdel-Kader (2000).

Table 4. Proximate chemical composition of thick kmaj bread[1].

Sample	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Fiber (%)	Carbohydrate (%)[2]
WF	32.20 ± 0.10^{a}	0.96 ± 0.13^{c}	12.89 ± 0.12^{d}	1.06 ± 0.01^{b}	0.43 ± 0.03^{d}	52.46^{a}
WF + 5% FBF	28.90 ± 0.12^{b}	2.35 ± 0.15^{b}	18.25 ± 0.14^{c}	1.15 ± 0.12^{a}	0.61 ± 0.05^{c}	48.74^{b}
WF + 10% FBF	27.60 ± 0.14^{c}	2.42 ± 0.12^{ab}	19.36 ± 0.12^{b}	1.17 ± 0.11^{a}	0.89 ± 0.11^{b}	48.56^{b}
WF + 15% FBF	26.55 ± 0.11^{d}	2.55 ± 0.13^{a}	19.69 ± 0.15^{a}	1.23 ± 0.16^{a}	1.00 ± 0.15^{a}	48.98^{b}

[1] Data presented as means ± SD of 3 determinations.
[2] Carbohydrate = 100 - (moisture + ash + protein + fat + crude fibre).
FBF = faba bean flour; WF = wheat flour.
Values with different superscript letters in the same column are significantly different ($P \leq 0.05$) according to the least significant difference test.

Table 5. Characterisation of thick kmaj bread[1].

Sample	Volume (cc)[2]	Weight (g)[2]	Specific volume (cc/g)	Upper layer (%)
WF	75.00^{a}	47.00^{c}	1.60^{a}	54.90^{a}
WF + 5% FBF	57.44^{b}	54.70^{a}	1.05^{b}	51.83^{b}
WF + 10% FBF	53.89^{c}	55.56^{a}	0.97^{b}	52.50^{b}
WF + 15% FBF	51.23^{c}	56.92^{a}	0.90^{b}	53.96^{a}

[1] Data presented as means.
[2] The given value is the mean of 5-loaves replicate measurements taken within 2 h after baking.
FBF = faba bean flour; WF = wheat flour.
Values with different superscript letters in the same column are significantly different ($P \leq 0.05$) according to the least significant difference test.

Table 6. Sensory evaluation of thick kmaj bread supplemented with faba bean flour.[1]

Sensory attributes (maximum score[2])	WF	WF + 5% FBF	WF + 10% FBF	WF + 15% FBF
Day 1				
Crust colour (5)	4.14^{a}	3.45^{b}	3.70^{ab}	3.57^{b}
Brown or black spots (5)	3.28^{a}	3.35^{a}	3.20^{a}	3.38^{a}
Cracks (5)	4.07^{a}	3.93^{a}	4.13^{a}	3.72^{a}
Crispness (5)	2.42^{b}	3.72^{a}	3.55^{a}	3.38^{a}
Crumb colour (5)	4.40^{a}	3.18^{c}	3.72^{bc}	3.47^{bc}
Evenness of cells (5)	3.78^{a}	3.61^{a}	3.70^{a}	3.66^{a}
Smoothness (5)	3.28^{a}	3.49^{a}	3.57^{a}	3.50^{a}
Shine and sheen (5)	4.35^{a}	3.59^{ab}	3.12^{b}	2.87^{b}
Ease of chewing (5)	4.07^{a}	3.88^{ab}	3.30^{abc}	2.77^{c}
Pocket formation (5)	4.64^{a}	4.38^{a}	4.52^{a}	4.45^{a}
Flour lumps (5)	4.85^{a}	4.50^{a}	4.38^{a}	4.50^{a}
Rolling and folding (5)	4.35^{a}	4.56^{a}	4.02^{ab}	3.42^{b}
Taste (15)	12.92^{a}	12.57^{a}	12.03^{a}	11.73^{a}
Day 2				
Pocket formation (5)	3.75^{a}	3.50^{a}	3.78^{a}	3.12^{b}
Ease of chewing (5)	3.82^{ab}	4.00^{a}	3.77^{b}	3.78^{ab}
Rolling and folding (5)	3.71^{a}	3.39^{ab}	3.25^{bc}	3.00^{c}
Taste (10)	6.92^{a}	6.78^{ab}	6.50^{c}	6.00^{c}
Total score (100)	78.75^{a}	75.92^{ab}	74.23^{b}	70.35^{c}

[1] Data presented as means.
[2] Assigned by 10 panellists.
FBF = faba bean flour; WF = wheat flour.
Values with different superscript letters in the same rows are significantly different ($P \leq 0.05$) according to the least significant difference test.

Sensory evaluation for the kmaj bread produced from WF and different levels of FBF are shown in Table 6. The results of the first day evaluation showed that black spots, cracks, evenness of the cell, smoothness, pocket formation, flour lumps and taste did not differ significantly whether the bread was made of wheat flour or FBF, while crust colour, crumb colour, shine and sheen, ease of chewing, rolling and folding were scored highest in bread produced from wheat flour. Crispness was the highest in the bread produced from FBF. All the sensory characteristics of the breads made from FBF were not significantly different from one another.

On the second day of evaluation after baking, the sensory characteristics of pocket formation, ease of chewing, rolling, folding and taste showed no significant differences ($P > 0.05$) for bread produced from WF and 5% FBF. The sensory characteristics on the second day of evaluation were scored lower in the bread produced from 15% FBF.

There was no significant difference between bread produced from WF and 5% FBF in relation to the total sensory score. The lowest total score was obtained with bread produced from 15% FBF, while the sensory characteristics of bread produced from 10% FBF were within acceptable sensory limits. Those results confirm those obtained by Abdel-Kader (2000) for the production of Egyptian 'balady' bread.

4. Conclusions

The results of this study indicate the possibility of using legumes (faba bean) in thick kmaj bread production and confirmed the current tendency for enhancing traditional products and improving their nutritional values, e.g. by increasing protein, mineral and fibre by increasing levels of replacements of wheat flour. Organoleptic 'sensory' evaluation indicated that the overall sensory score of thick kmaj bread were acceptable with up to 10% FBF levels with improvement of protein, minerals (ash) content compared with the wheat flour bread.

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