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Utilization of Decorticated Pigeon Pea (*Cajanus cajan* L.) With Wheat (*Triticum aestivum*) Flours in Bread Making

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Abstract: The objectives of this study were to investigate the use of decorticated pigeon pea flour in the development of protein rich - bread, suitable for general and specific nutritional purposes and to study the effect of incorporation of pigeon pea flour on the sensory evaluation and quality of bread produced. Decorticated Pigeon Pea Flour (DPPF) was incorporated with wheat flour (WF 72% Ext.) to replace 0, 5, 10, 15, 20 and 25% of the wheat flour for bread making. Proximate composition, falling number, gluten quality and quantity, tannins and phytic acid were determined for the flour blends (Composite flour). Bread proximate composition, sensory evaluation and specific volume were determined as well. Decortication of pigeon pea led to decrease in moisture, ash, tannins and phytic acid and increase in the protein and carbohydrates contents. The falling number (alpha amylase activity) significantly increased over the control with the increasing level of DPPF. There were also significant reduction ($p \leq 0.05$) on gluten quantity (wet and dry gluten) and quality (gluten index). No significant differences were found in bread specific volume up to 10% addition of DPPF. The protein, ash, fat contents and calorific values for the bread were significantly increased ($p \leq 0.05$) with incorporation of DPPF. Increasing levels of the replacement of DPPF resulted in a decrease in the organoleptic quality of the bread. The bread containing up to 15% DPPF was found to be the best in overall acceptability.

Key words: Calorific value, composite flour, decortication, proximate composition, quality

INTRODUCTION

Cereal grains such as wheat, sorghum maize…etc. are nutritionally characterized by respectively low levels of proteins, and are deficient in some essential amino acids, among which lysine is the most important, but have adequate amounts of sulfur-containing amino acids. Hence, essential amino acid(s) deficient in cereals are complemented with addition of legumes (Hulse, 1989).Supplementation of cereals with legumes has been advocated as a way of combating Protein-energy Malnutrition (PEM) problems in developing countries. Legumes as a supplement bring to the cereal-based diets a variety of taste and texture (Faris and Singh, 1990).

Food legumes form an important component of the diets of people in many developing countries of Asia and Africa. They are cheaper source of proteins when compared to animal proteins. Clinically, legumes were reported to reduce levels of cholesterol and glucose in blood (Soni *et al*., 1982). Among food legumes, pigeon pea (*Cajanus cajan* L.) also called red gram or tuar (in Sudan known locally as "Lubia Addassy"); is a member of the family *Leguminasea*. It is a valuable source of low-cost vegetable protein, minerals and vitamins and occupies a very important place in human nutrition.

Pigeon pea protein is a rich source of lysine, but is usually deficient in sulphur-containing amino acids, methionine and cystine; it thus supplements the essential amino acids in cereals as reported by Gopalan *et al*. (1971). Daniel *et al*. (1970) found that incorporation of 8.5% decorticated pigeon pea in a rice diet, and 16.7% in a finger millet diet improved the diets' nutritive value. Kurien *et al*. (1971) reported that the nutritive value of the wheat-based diets was considerably improved when supplemented with pigeon pea. Pigeon pea is rarely used in baked foods and confectionary products. Gayle *et al*. (1986) reported that physical, sensory and nutritional characteristics of breads supplemented with pigeon pea flour up to 25% showed no significant differences ($p<0.05$) compared with un supplement bread.

The bread from 10% pigeon pea flour blend with 2-3% vital gluten and 0.5% Sodium Stearoyl 2-Lactylate (SSL) had high loaf volume and loaf quality as stated by Harinder *et al*. (1999). Sulaiman (2005) studied the effect of bread quality by the addition of chick pea to wheat flour and found that bread contained 7.5% chick pea flour could be baked with satisfactory performance. Mohammed (2002) reported that the amino acids analysis confirmed the great beneficial effects of pigeon pea supplementation on Feterita sorghum nutritional value.

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Table 1: Proximate composition and anti-nutritional factors of wheat and pigeon pea flours (on dry matter basis)

Types of flour	Moisture (%)	Ash (%)	Protein* (%)	Fat (%)	Tannins Mg/100g	Phytic acid	CHO**(%)
Wheat Flour (WF)	12.26	0.65	13.80	1.33	-	-	71.06
Whole Pigeon Pea Flour (WPPF)	9.53	3.96	22.55	2.13	0.13	127.96	61.73
Decorticated Pigeon Pea Flour (DPPF)	8.50	3.73	23.23	2.07	0.03	68.55	62.47

*: Factor of wheat flour N × 5.7; and for pigeon pea N × 6.25; **: Calculated by difference

Table 2: Falling number and gluten quality and quantity of bread wheat flour as affected by inclusion of DPPF

		Gluten (%)		
Flour blends	Falling no. (sec.)	Wet gluten	Dry gluten	Gluten index
100% WF (Control)	554.0±10.44^{c}	32.250±0.25^{a}	10.650±0.15^{a}	80.730±0.48^{a}
95%WF+5% DPPF	627.0±08.54^{b}	32.450±0.05^{a}	10.250±0.05^{ab}	63.177±1.95^{bc}
90%WF10% DPPF	614.7±03.06^{b}	31.300±0.30^{b}	9.950±0.05^{bc}	62.290±5.87^{bc}
85WF+15% DPPF	663.0±02.65^{a}	30.450±0.05^{c}	9.700±0.10 ^{cd}	60.777±2.07^{c}
80%WF+20%DPPF	654.7±02.89^{a}	29.850±0.35^{c}	9.250±0.15^{de}	62.910±5.96^{bc}
75%WF+25%DPPF	621.7±04.93^{b}	25.500±0.30^{e}	8.100±0.10^{f}	60.187±1.06^{c}
Calculated F-ratio	550.572*	129.835*	27.072	13.659
C.V%	1.23%	1.48%	3.00%	4.55%
$Lsd_{5\%}$	11.99	0.7418	0.4882	5.118

#Mean values (±SD) having different superscript letters in the same column differ significantly ($p \leq 0.05$); WF: Wheat flour; DPPF: Decorticated pigeon pea flour

In general, the bread making potential decreases linearly with the proportion of non-wheat flour. Bloksma and Bushuk (1988) stated that the characteristics of the dough are depending on the type of flour, quality and quantity, ingredients used and mixing conditions.

MATERIALS AND METHODS

Materials: Australian wheat flour was obtained from Flour Mills in Khartoum North. Pigeon pea (*Cajanus cajan* L.) (Brown colored seeds) were purchased from the local market during the harvest season of 2002/2003.The added materials used in processing bread i.e. yeast, salt, sugar, shortening, ascorbic acid were purchased from the local market.

Methods: Pigeon pea was decorticated into its dicotyledons (dhal/splits), according to the methods of Hassan and Bureng (1996). The clean decorticated pigeon pea seeds were ground into flour using an efficient Pulverizer (80-100 mesh). Decorticated pigeon pea and wheat flours blends were prepared in such a way that DPPF replaced WF at 5, 10, 15, 20 and 25% levels. All the blends prepared were used for the different analysis.

Falling number (α-amylase activity) was determined according to the method of the ICC (1999) method; No56-81 B, gluten quality and quantity were determined according to the standard method of the AACC (2000). Breads were made according to the method of Badi *et al.* (1978). The loaf volume expressed in cubic centimeters was determined by seeds displacement method (Volumeter) according to Pyler (1973). The specific volume of the loaf was calculated according to the AACC (2000) by dividing loaf volume (cm^3) by its weight (g). The finished loaf bread samples were assessed organoleptically by ranking test according to the procedure described by Ihekoronye and Ngoddy (1985). Fifteen semi-trained assessors were asked to evaluate the general appearance, flavor, taste, texture and overall quality of the loaf bread. Sum of ranks were then statistically interpreted according to the same ranking test described by the same authors.

RESULTS AND DISCUSSION

Proximate composition of Wheat Flours (WF), Whole seeds of Pigeon Pea (WPP) and Decorticated Pigeon Pea Flour (DPPF) is presented in Table 1. Wheat flour was found to contain 12.26% moisture, 0.65% ash, 13.8% protein, 1.41% fat, 71.88% carbohydrates. These results are in agreement with those reported by Pyler (1973), Kent-Jones and Amose (1967), Schruben (1979) and Eltoum (2004). On the other hand the whole seeds of pigeon pea and decorticated pigeon pea flours were found to have 9.53 and 8.50% moisture; 22.55 and 23.23% protein; 3.96 and 3.73% ash; 2.13 and 2.07% fat and 61.73 and 62.47% carbohydrates, respectively. Hulse (1977) found that the protein content of pigeon pea seed samples ranged between 18.5 and 26.3% with a mean value of 21.5%. Singh and Jambunathan (1981) found that the protein content of 43 commonly cultivated varieties ranged between 17.9 and 24.3% for whole seeds, and between 21.1 and 28.1% for decorticated (Dhal) samples. Dahiya *et al.* (1977) reported a high environmental influence on protein content, and a negative correlation between yield and percentage-seed protein. Mohammed (2002) reported values of 3.63 and 3.37% ash, 19.88 and 21.62% protein and 2.41 and 2.07% fat for whole and decorticated pigeon pea flour, respectively. Decortication of pigeon pea seeds resulted in an increase of protein and

Table 3: Loaf bread specific volume of wheat flour as affected by inclusion of DPPF

Flour blends	Bread volume cm^3	Bread weight (g)	Bread specific volume (cm^3/g)
100% Wheat Flour (WF)	370.0±10.00^e	108.6±1.05^b	3.45±0.02^c
95% WF+5% DPPF	391.7±02.89^d	109.1±0.75^b	3.59±0.05^c
90% WF+10% DPPF	380.0±08.66^f	109.7±0.95^b	3.47±0.11^c
85% WF+15% DPPF	350.0±00.00^g	109.4±0.49^b	3.20±0.02^d
80% WF+20% DPPF	320.0±05.00^h	110.4±1.89^a	2.90±0.06^e
75% WF+25% DPPF	310.0±08.66^i	108.6±0.06^a	2.86±0.08^e
C.V%	2.08%	0.94%	2.50%
$Lsd_{5\%}$	13.91	1.731	0.1354

#Mean values (±SD) having different superscript letters in the same column differ significantly ($p \leq 0.05$); WF: Wheat flour; DPPF: Decorticated pigeon pea flour

Table 4: Sensory evaluations of wheat loaf bread containing decorticated pigeon pea flour

	Sum of ranks				
Flour blends	General appearance	Odor	Taste	Texture	Overall quality
100% Wheat Flour (WF)	89^a	73^a	80^a	92^a	94^a
95% WF+5% DPPF	50^b	49^b	50^b	51^b	56^b
90% WF+10% DPPF	50^b	50^b	51^b	46^b	53^b
85% WF+15% DPPF	48^b	61^a	60^c	50^b	54^b
80% WF+20% DPPF	67^c	80^c	69^c	72^c	75^c
75% WF+25% DPPF	95^a	87^c	87^a	86^a	88^c

Mean values (±SD) having different superscript letters in the same column differ significantly ($p \leq 0.05$); WF: Wheat flour; DPPF: Decorticated pigeon pea flour

carbohydrates and reduction of fat and ash. These results were in agreement with the results obtained by Mohammed (2002). The tannins content of whole pigeon pea was 0.13 mg/100 g, while decorticated pigeon pea gave a value of 0.03 mg/100 g material. Similar values were reported by Singh (1988) for ten cultivars, and also Mohammed (2002). Decortication has been reported to influence the polyphenolic compounds and eliminate their levels. Rao and Deothale (1982) reported that decortication of chickpea and pigeon pea has been reported to reduce polyphenolic compounds by 90%. Soaking followed by cooking before consumption is suggested as a mean of removing harmful effects of polyphenolic compounds in the regions where these pulses are consumed as whole seeds, as stated by Rao and Deothale (1982). Phytic acid results obtained in this study for whole and decorticated pigeon pea flours were 127.96 and 68.55 mg/100 g (DM), respectively. These values obtained were lower than the values obtained by Mohammed (2002).

The falling number value (alpha-amylase activity) of WF was found to be 554 sec. Substitution of DPPF in WF increased the values of falling number (low alpha-amylase) which ranged from 614 to 663 sec. (Table 2). Statistical analysis showed no significant differences ($p \leq 0.05$) between the ratios of 5, 10 and 25% of DPPF in WF. Highly significant differences ($p \leq 0.05$) were observed between 15 and 20% of DPPF. Alpha-amylase may be added to wheat flour to achieve any desired level of enzyme activity. The optimum level of enzyme activity is ultimately governed by the end use of the flour and the type of processing involved as mentioned by Mailhot and Patton (1988).

Gluten quantity (wet and dry) and gluten quality (gluten index) of doughs prepared from DPPF with WF are presented in Table 2. Incorporation of DPPF in WF gave values of wet gluten ranged from 25.5 to 32.45% compared to 32.25% for WF (control). No significant differences ($p \leq 0.05$) were observed by addition of 5% DPPF to WF. Increasing levels of DPPF resulted in a significant decrease ($p \leq 0.05$) in wet gluten. The wet gluten content of the whole flour of Sudanese cultivars was found in the range of 26.2 to 31.9% as reported by Mohammed (2000). And the dry gluten percentage was found to be 10.65%. Increasing levels of DPPF gave values ranged from 10.25 for 5 to 8.1% for 25% DPPF.

The effect of decorticated pigeon pea flour (DPPF) on loaf bread specific volume of WF is shown in Table 3. No significant differences ($p \leq 0.05$) were observed in bread specific volume for 5 and 10% DPPF replacements. The bread specific volume then decreased gradually till it reached its lowest value (2.86 cc/g) for 25% DPPF. These findings agreed with the results obtained by Mustafa *et al*. (1986) who found that beyond 10% replacement of wheat flour by cowpea flour, the specific volume of the bread decreased. The decrease in bread specific volume is attributed to the dilution of gluten content and hence resulted in lower gas retention and lower bread volume.

Sensory evaluations of loaf bread: Sensory evaluation of the bread containing (DPPF) is presented in Table 4. General appearance, odor, taste, texture and overall quality of breads made with up to 10% DPPF level of replacement were found to be significantly better than the control bread. No significant differences ($p \leq 0.05$) were observed between 5, 10 and 15% DPPF in all sensory

Table 5: Chemical composition and energy value of wheat flour bread containing different levels of DPPF

Flour blends	Dry matter (%)	Ash(%)	Protein (%)	Fat(%)	Carbohydrates (%)	Calorific value (kcal/100 g) DM
100% Wheat Flour (WF)	94.14^{d}	0.973^{g}	14.62^{f}	1.38^{d}	77.17^{a}	386.0^{fg}
95% WF+5% DPPF	94.41^{ab}	1.033^{f}	15.18^{e}	1.54^{cd}	76.61^{b}	387.2^{de}
90% WF+10% DPPF	93.87^{e}	1.137^{e}	15.51^{e}	1.83^{bc}	75.46^{c}	386.2^{fg}
85% WF+15% DPPF	93.92^{e}	1.216^{c}	16.10^{d}	2.63^{a}	74.31^{e}	387.7^{d}
80% WF+20% DPPF	94.25^{cd}	1.279^{b}	16.66^{c}	2.52^{a}	73.79^{f}	389.1^{c}
75% WF+25% DPPF	94.34^{bc}	1.417^{a}	16.97^{c}	2.70^{a}	73.25^{g}	390.1^{b}
SE±CV (%)	0.04±20.08	0.009±1.36	0.131±1,29	1.10±28.54	0.144±0.34	0.28±10.13

Mean values having different superscript letters in the same column differ significantly ($p \leq 0.05$); WF: Wheat flour; DPPF: Decorticated pigeon pea flour

characteristics; except odor and taste for 15% DPPF level, which showed significant differences from the other levels. It seems that addition of DPPF affected the odor and taste and this sharp decrease is probably due to the domination of pigeon pea odor at the increasing levels. These results were in agreement with the findings obtained by Sulaiman (2005) who found that at 10% level, chickpea odor was dominant in the loaf bread.

Chemical composition and energy value of bread: Table 5 shows the effect of DPPF on chemical composition and energy value of wheat flour bread. Increasing level of DPPF in bread resulted in a significant increase ($p \leq 0.01$) in ash, protein and fat contents. Values of ash ranged from 1.033 for 5% to 1.417% for 25% replacement of DPPF, compared with wheat bread (Control) 0.973%.

The protein content increased significantly ($p \leq 0.01$) with increasing levels of DPPF. The protein content of wheat bread was found to be 14.62%. This value increased to 15.18, 15.51, 16.10, 16.66 and 16.97 for replacements of 5, 10, 15, 20 and 25% DPPF, respectively. No significant differences were observed between 5 and 10% and between 20 and 25% replacements. These results of ash and protein obtained were similar to those reported by Sulaiman (2005), who had supplemented wheat flour with chick pea flour to produce bread.

The control wheat bread had the highest content of carbohydrates (77.17%).This value was significantly decreased ($p \leq 0.01$) with increasing levels of supplementation till it reached 73.05% for the high level (25% DPPF) of replacement. Significant increase ($p \leq 0.01$) in calorific values were observed due to incorporation of DPPF; from 387.2 for 5% DPPF to 390.1 Kcal/100 g for 25% replacement, compared with control wheat bread 386.0 Kcal/100 g.

CONCLUSION

It is concluded that, incorporation of decorticated pigeon pea flour in wheat flour improved the nutritional value of produced bread i.e. increase in ash (mineral), protein, and calorific values with increasing levels of replacement. Bread supplemented with DPPF at the level of 10% was found more acceptable in all quality attributes than wheat bread.

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