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EFFECT OF INCORPORATION OF CHICK PEA HUSK ON QUALITY CHARACTERISTICS OF BISCUITS

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In recent years there has been a reawakening of interest in the role of dietary fiber in human nutrition and thus tremendous importance is now being given to various cereal brans, legume husks and other potential sources of dietary fiber in the formulation of food products. Chickpea is a multipurpose grain legume widely used around the world, notably as a source of protein, carbohydrates and dietary fibre. The study was conducted to study the effect of incorporation of chickpea on proximate composition, physical and sensory qualities as well as antioxidant properties. Replacement of refined wheatflour with up to 20% chickpea husk produced fibre-enriched biscuits with moderately desirable overallacceptability.The total dietary fibre content of biscuits increased significantly from 2.15 to 10.48% with incorporation of chickpea husk. The DPPH activity increased from 40.76 to 87.44% whereas Ferric reducing power increased from 23.48 to 48.11 mg Ascorbic acid/100 g on incorporation of 25% chickpea husk.

Keywords: Chickpea, Husk, Functional, Biscuits, Antioxidant

INTRODUCTION

Chickpea is a good source of important vitamins such as riboflavin, niacin, thiamine, folate and the vitamin A precursor (β-carotene). It is also a good source of carbohydrates and protein, and the protein quality is considered to be better than other pulses. Chickpea husk also has several potential health benefits and it also contains high amount of antioxidant as the flavonoids and polyphenols are higher in the outer layers.Although richin nutritive value and fibre content it is still not being fully utilized in the industry. Dietary fibre is a complex of non-digestible carbohydrates and lignin that are intrinsic and intact in plants and are resistant to digestion and absorption in the small intestine. Dietary fibre promotes beneficial physiological effects such as laxation, reduction in blood cholesterol and postprandial blood glucose modulation.

Recently, the uses of legume husks have gained importance as the ingredients in the formulation of various food products. Moreover, the legume husk is potentially low cost and is largely available throughout the country. Recent study (Shams-Ud-Din *et al.*, 2006) showed that the processed pea husk could beconveniently utilized in formulations of breads. The dietary fiber enriched with extracted legume husk maybe added to foods in an appealing manner to ensure consumer acceptance. The legume husks are rich indietary fiber (80-93%) and calcium (32-50%), where the dietary fiber consists of about 27-47% crude fiberand 47-60% Nitrogen-free carbohydrate (Singh *et al.*, 1982).

The replacement of refined wheat flour with chickpea husk will enhance the nutritional quality of biscuits. The chickpea husk-refined wheat flour blend will provide

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improved protein quality and high fibre content. Therefore in the present study the feasibility of partially replacing wheat flour with chickpea husk for biscuit making was investigated.

MATERIALS AND METHODS

The chickpea variety K 850 was procured from S.V. Patel University of Agriculture and Technology, Meerut.Other raw materials such as sugar, butter and refined flour were purchased fromlocal market of Allahabad.

Preparation of Chickpea Husk: Chickpea seeds (desi) were subjected to millingto remove the husk and to obtain dhal. At the beginning of the process, cleaned chickpea seeds weresubjected to pitting (scratching the husk). During this treatmentthe husks were removed partially or opened up. Around 10% water was added to these partially opened seeds and mixed thoroughlyfor uniform moisture penetration into the cotyledons, followed byan equilibrium period of about 2 h. At the end of this stage themoisture content of seeds was 18%. The moistened seeds were then dried at 45-50% C for 5 h. Drymilling was done in a dhal mill to obtain different fractions suchas dhal, husk and broken seeds.

Proximate Composition

Protein (micro-Kjeldahl), fat, moisture, ash and crude fiber were determined by the AOAC (2005) methods. The carbohydrate content was calculated by difference method.

Functional Properties

The water and oil absorption capacities were determined by the method of Sosulski *et al.* (1976). The sample (1.0 g) was mixed with 10ml distilled water or refined soybean oil, kept at ambient temperature for 30 min and centrifuged for 10 min at 2,000×g. Water or oil absorption capacity was expressed as percent water or oil bound per gram of the sample.The bulk density was determined according to the method described by Okaka and Potter (1977). The sample (50 g) was put into a 100 ml graduated cylinder and tapped 20-30 times. The bulk density was calculated as weight per unit volume of sample.

The method of Okaka and Potter (1977) with some modifications was used for determining the swelling capacity. The sample filled up to 10 ml mark in a 100 ml graduated cylinder was added with water to adjust total volume to 50 ml. The top of the graduated cylinder was tightly covered and mixed by inverting the cylinder. The suspension was inverted again after 2 min and allowed to stand for further 30 min. The volume occupied by the sample was taken after 30 min.

Foaming capacity was determined as described by Narayana and Narasinga Rao (1982) with slight modifications. Sample (1.0 g) was added to 50 mldistilled water at 30±2 °C in a graduated cylinder. The suspension was mixed and shaken for 5 min to foam. The volume of foam after whipping for 30 s was expressed asfoaming capacity.

$$FC = \frac{Volume\ of\ foam\ (AW) - Volume\ of\ foam\ (BW)}{Volume\ of\ foam\ (BW)} \times 100$$

Product Development

Biscuit were prepared from refined wheat flour and chickpea husk blends in the ratios of 100:0, 95:5, 90:10, 85:15, 80:20 and 75:25 respectively. Refined wheat flour biscuits were considered as control. The standardized recipe for the biscuits had the ingredients as 100 g flour, 60 g sugar, 40 g ghee, 1.5 g ammonium bicarbonate and required amount of milk. Ghee and ground sugar were taken and creamed to a uniform consistency. The flour, required amount of milk and ammonium bicarbonate were added to the creamed mixture and mixed for 8 min at medium speed in dough mixer to obtain a homogenous mixture. The dough was rolled out into thin sheet of uniform thickness and was cut into desired shape using mould. The cut pieces were placed over a perforated tray and transferred into a baking oven at 190 °C for 10-15 min till baked. The well baked biscuits were removed from the oven, cooled to room temperature, packaged and stored in air tight container till further use.

Physical Analysis of Biscuits

Diameter of biscuits was measured by laying six biscuitsedge to edge with the help of a scale rotating them at 90° and again measuring the diameter of six biscuits (cm)and then taking average value. Thickness was measuredby stacking six biscuits on top of each other and takingaverage thickness (cm). Weight of biscuits was measuredas average of values of four individual biscuits with thehelp of digital weighing balance. Spread ratio wascalculated by dividing the average value of diameter byaverage value of thickness of biscuits. Percent spreadwas calculated by dividing the spread ratio of high fibrebiscuits with spread ratio of control biscuits and multiplying by 100.

Fracture strength of biscuits was measured with the help of Texture Analyzer (model TA-XT2i, Stable Micro systems, UK) using a 3-point Bending Rig and 5 kg load cell. The distance between the two beams was 40 mm. Another identical beam was brought down from above at a pre-test speed of 1.0 mm/s, test speed of 3.0 mm/s, post-test speed of 10.0 mm/s. The downward movement was continued till the biscuit broke. The peak force was reported as fracture strength. Textural analysis test was conducted for a sample of five biscuits three hours after baking (Yadav *et al.*, 2012).

Nutritional Analysis of Biscuits

Protein fat, moisture, ash and crude fiber were determined by the AOAC (2005) methods. The carbohydrate content was calculated by difference method. Total dietary fibre was estimated by enzymatic-gravimetric method no. 991.43 (AOAC, 2006)

Sensory Analysis of Biscuits

Biscuit samples were evaluated for sensory characteristics by a panelof 10 semi-trained members using a 9 point Hedonic scale. The biscuits were evaluated fortheir color, appearance, lavour, texture, taste and overall acceptability (Ranganna, 2005).

Antioxidant Analysis of Biscuits

Estimation of Total Phenolic Content (TPC)

Total phenolic content was determined by adopting Folin-Ciocalteu method (Velioglu *et al.,* 1998; and Ying *et al.,* 2013). Basically, 0.2 ml of extract was added to 1.5 ml of Folin-Ciocalteu reagent and mixture was allowed to stand at room temperature for 5 minutes. Then 1.5 ml of sodium carbonate solution (6%) was added into the mixture. Absorbance was measured using spectrophotometer at 725 nm after incubating the sample to stand for 1½ hours at room temperature. Results were expressed as gallic acid equivalent in mg/100 g Dry Weight (DW).

DPPH Free Radical Scavenging Assay

The free radical scavenging activity of the extracts was estimated by measuring the decrease in absorbance of ethanolic DPPH solution at 517 nm in the presence of the extract (Krings and Berger, 2001; and Koolen *et al*., 2013). The initial concentration of DPPH was 0.1 mM and the reading was taken after allowing the solution to stand for 30 min. In cases where the absorbance decreased too much before the 30 minutes period the sample was appropriately diluted. The antioxidant activity was expressed as:

$$\text{DPPH\%} = \frac{\text{Control Absorbance} - \text{Sample Absorbance}}{\text{Control absorbance}} \times 100$$

Estimation of Reducing Power

The reducing power of the extracts was determined by using potassium ferricyanide- ferric chloride method (Oyaizu, 1986). Different dilutions of extracts amounting to 1 ml were added to 2.5 ml 0.2 M phosphate buffer (pH = 6.6) and 2.5 ml potassium ferricyanide (1%). The mixtures were incubated at 50 °C for 20 minutes, after which 2.5 ml trichloroacetic acid (10%) was added. 2.5 ml of the mixture was taken and mixed with 2.5 ml water and 0.5 ml of 1% ferric chloride. The absorbance at 700 nm was measured after allowing the solution to stand for 30 minutes.

Statistical Analysis

The data were reported as average of triplicate observations.The data were analyzed statistically in a completelyrandomized design (CRD) using one factor analysis ofvariance (ANOVA) (Yadav *et al.,* 2009).

RESULTS AND DISCUSSION

Proximate Analysis

The nutritional composition of refined wheat flour and chickpea husk is given in Table 1. Ash content was higher (3.51%) in chickpea husk as compared to refined wheat flour (1.28%). The crude fibre (23%) and carbohydrate (83.2%) content was also found to be higher in chickpea husk whereas protein content (12.86%) was higher in refined wheat flour. The results are in accordance with Bose and Shams Ud Din (2010) who reported similar values for ash, fat and protein content of chickpea husk. Similar results for refined wheat flour have also been reported by Yadav *et al.* (2012). The chickpea husk showed much higher total dietary fibre content in chickpea husk (19.82%) as compared to wheat flour (1.86%). Aguilera *et al.* (2009) and Tosh and Yada (2010) have also reported dietary fibre in chickpea husk in the range of 18-22g/100 g. Hemicelluloses constitute large part (~ 55%) of the total dietary fibre in kabuli and desi chickpea (Singh, 1984).

Functional Properties

The functional properties of refined wheat flour and chickpea husk are also presented in Table 1. Significant difference ($p<0.05$) was observed in Water Absorption Capacity (WAC) where chickpea husk showed lower WAC (74.91%) as compared to refined wheat flour (142%). Water absorption capacity is an important processingparameter and has implications for viscosity. It is alsoessential in bulking and consistency of products, as well as inbaking application (Niba *et al.*, 2001). The oil absorption capacity

Table 1: Proximate Composition (%) and Functional Properties of Chickpea Husk Powder and Refined Wheat Flour

	Chickpea Husk Powder	Refined Wheat Flour
Moisture	8.71±0.71	12.59±0.67
Ash	3.51±0.65	1.28±0.59
Fat	0.52±0.03	1.71±0.32
Crude Fibre	23.0±1.05	0.78±0.11
Protein	4.59±0.84	12.86±1.14
Total Carbohydrate	83.2±1.62	70.78±1.38
WAC (%)	14.91±0.81	142.0±2.15
OAC (%)	19.5±0.28	157.2±1.13
SC (ml)	18.5±1.46	16.48±0.86
FC (%)	0.3±0.02	12.38±0.79
BD (g/ml)	4.22±0.52	0.71±0.25
TDF (%)	19.87±1.24	1.86±0.49

Note: The values are mean ± SD (n = 3). WAC Water absorption capacity; OAC Oil absorption capacity; SC Swelling capacity; FC Foaming capacity; BD Bulk density, TDF Total Dietary fibre.

of refined wheat flour (157.2%) was significantly ($p<0.05$) higher than chickpea husk (59.5%). Higher oil absorption capacity may be due to higher number of hydrophobic groups than hydrophilic groups on the surface of protein molecules (Subaigo, 2006). Oil absorption index is important since oil acts as flavour retainer and increases the mouth feel of foods, improvement of palatability and extension of shelf life particularly in bakery or meat products where fat absorptions are desired (Aremu *et al.*, 2007).

Swelling capacity is the measure of increase in volume of a flour sample when soaked in water in relation to its initial volume. Swelling capacity was higher in chickpea husk (18.5 ml) than refined wheat flour (16.48 ml). The swelling power showsthe degree of the water absorption of the starch granules in theflour (Carcea and Acquistucci, 1997). Foaming capacity of refined wheat four was much higher (12.38%) as compared to chickpea husk (2.3%). Foaming is enhanced by surface active properties of protein present in flour. High foaming capacity is an essential requirement in development of baked products (Akubor *et al.*, 2000; and Alobo, 2003). The bulk density of chickpea husk was 1.22 g/ml significantly higher ($p<0.05$) than that of refined wheat flour (0.71 g/ml).

Proximate Composition of Biscuits

The proximate composition of biscuits is given in Table 2. Moisture content in the supplemented biscuits ranged from 2.6 to 5.4%, significantly higher than that of control biscuit (2.5%). Increase in moisture content of bakery products has been reported with increase in protein, ash and crude fibre content (Mustafa *et al.*, 1986). Our results are in accordance with Inam *et al.* (2010) where an increase in moisture and ash content has been reported on supplementation of chickpea husk in chapatti. The protein content of biscuits increased significantly ($p<0.05$) as the substitution level increased and was highest (6.37%) at 25% replacement level. The fat content increased from 0.5% to 1.67% on increasing the concentration of chickpea husk from 0-25% in the blend. The crude fibre content of biscuits increased with the replacement level of chickpea husk. Crude fibre content was found to be maximum (17.41%) in 25% chickpea husk supplemented biscuits and minimum (1.56%) in control sample. Bose and Shams Ud Din (2010) have also reported an increase in crude fibre content on supplementation of chickpea husk in cracker biscuits.

Dietary Fibre (DF) is the indigestible part of plant food in the human small intestine. DF is composed of poly/oligosaccharides, lignin and other plant-based substances (AACC, 2001). The total dietary fibre content of biscuits increased significantly from 2.15 to 10.48% with incorporation of chickpea husk. The TDF content in commercial fibre rich cookies/biscuits has been reported to be in the range of 3.73-5.95 g/100 g on dwb (Sangronis and Rebolledo, 1993; and Ajila *et al.*, 2008).

Physical Characteristics

The physical properties of biscuits prepared from chickpea husk and refined wheat flour are shown in Table 2. The diameter of chickpea husk incorporated biscuit was found higher than that of control biscuit. The thickness of biscuits ranged from 0.72-0.8 cm. The thickness of biscuits also increased with incorporation of chickpea husk. The variation in diameter and thickness were reflected in spread ratio and percent spread of biscuit. Spread ratio and percent spread decreased with addition of chickpea husk except at 20 and 25% incorporation level which had spread ratio and percent spread factor higher than that of control biscuits. Rababah *et al.* (2006) reported reduction in spread ratiowhen the

Table 2: Proximate Composition (%) and Physical Properties of Biscuits

	A	B	C	D	E	F
Moisture	2.51±0.15^{a}	2.63±0.11^{a}	3.41±0.21^{b}	4.50±0.16^{c}	4.92±0.1^{c}	5.41±0.14^{d}
Ash	29.62±0.25^{c}	29.03±0.48^{c}	27.64±0.35^{b}	26.20±0.28^{b}	21.31±0.59^{a}	19.72±0.38^{a}
Fat	0.55±0.07^{a}	1.02±0.08^{b}	1.31±0.04^{c}	1.34±0.09^{c}	1.55±0.02^{d}	1.67±0.04^{d}
Crude Fibre	1.56±0.14^{a}	3.87±0.08^{b}	4.25±0.19^{b}	8.64±0.85^{c}	13.75±0.91^{d}	17.41±0.37^{e}
Protein	3.93±0.15^{a}	4.12±0.27^{a}	5.04±0.74^{b}	5.68±0.64^{b}	6.12±0.58^{c}	6.37±0.43^{c}
Total CHO	63.47±0.29^{b}	63.28±0.94^{b}	62.66±0.82^{a}	62.32±0.67^{a}	66.18±0.88^{c}	66.86±0.75^{c}
TDF (%)	2.15±0.87^{a}	3.44±0.59^{a}	5.86±0.47^{b}	7.52±0.68^{c}	8.94±1.05^{c}	10.48±0.93^{d}
Diameter (cm)	3.81±0.13^{a}	3.90±0.29^{a}	4.12±0.86^{b}	4.25±0.64^{c}	4.21±0.38^{c}	4.33±0.19^{c}
Thickness (cm)	0.72±0.07^{a}	0.78±0.06^{b}	0.80±0.02^{c}	0.82±0.10^{c}	0.77±0.03^{b}	0.75±0.07^{a}
Weight (g)	11.49±0.54^{c}	11.35±0.58^{b}	11.54±0.31^{c}	11.01±0.28^{a}	11.25±0.63^{b}	10.93±0.44^{a}
Spread Ratio	5.27±0.21^{b}	5.07±0.29^{a}	5.12±0.61^{a}	5.25±0.53^{b}	5.45±0.97^{c}	5.73±0.42^{d}
% spread factor	100.00±0.15^{b}	94.87±0.42^{a}	97.15±0.35^{b}	99.62±0.54^{b}	103.41±0.61^{c}	108.72±0.83^{d}
Fracture Force (N)	10.11±0.58^{a}	11.58±0.87^{a}	13.46±0.92^{b}	15.74±1.05^{c}	16.21±0.81^{c}	16.96±1.02^{d}

Note: The values are mean ± SD (n = 3); the carbohydrate content was determined by subtraction method. Values with similar superscripts in a row do not differ significantly ($p<0.05$), A = Control; B = 95 RWF: 5 CH; C = 90 RWF:10 CH; D = 85 RWF:15 CH; E = 80 RWF:20 CH; F = 75 RWF:25 CH, RWF Refined wheat flour; CH Chickpea Husk, TDF Total Dietary fibre.

chickpea, broad bean and isolated soy proteinwere substituted for wheat flour in biscuits. Other research workers also reported reduction in spread ratio when soy flour and fenugreek flour were substituted for wheat flour (Singh *et al.*, 1996; and Hooda and Jood, 2005).

Texture is an important quality characteristic which makes a significant contribution to the overall quality and acceptance of food specially baked products (Bourne, 1990). The fracture force is also one of the criteria to measure the biscuit hardness and the results for same are summarized in Table 2. The fracture force was found to be lowest for control sample (10.11 N) which increased significantly to 16.96 N on incorporation of chickpea husk at 25% level. The texture of baked biscuits is primarily attributable to starch gelatinization and super cooled sugar rather than a protein/ starch structure (Gallagher, 2002). This may be the reason for increase in hardness of the biscuits with increase in chickpea husk incorporation.

Sensory Characteristics

Table 3 depicts the effect of chickpea husk incorporation on the sensory characteristics of biscuits. With the increase in the level of chickpea husk in the formulation, the sensory scores of biscuits decreased. However the biscuits prepared by replacing refined wheat flour upto 20% chickpea husk were similar to control biscuits with respect to colour, appearance, taste, flavour,texture and overall acceptability. Increasing the levels ofincorporation of chickpea husk above 20% resulted insignificantly decreased ($p<0.05$) score for quality characteristicsand this decreasing effect was more pronounced inthe texture of the biscuits as the biscuits produced weremuch harder in texture. Replacement of refined wheatflour with up to 20% chickpea husk producedfibre–enriched biscuits with moderately desirable overall acceptability.

Antioxidant Activity

The total polyphenol content in the control and supplemented biscuits showed that addition of chickpea husk increased the content of phenolics in the enriched biscuits from 33.76 to 92.54 mg GAE/100 g (Table 4). Even though baking and cooking significantly decreases the polyphenolic content still it was higher in chickpea husk incorporated biscuits. DPPH radical scavenging activity is a widely used method to evaluate antioxidant activity (Gadow *et al.*, 1997). With increase in level of chickpea husk,

Table 3: Sensory Quality Characteristics of Biscuits

	Colour	Appearance	Taste	Flavour	Texture	Overall Acceptability
A	8.5±0.21[c]	8.1±0.45[c]	8.5±0.51[c]	8.3±0.37[c]	8.3±0.15[d]	8.4±0.59[c]
B	8.2±0.25[c]	7.9±0.73[c]	8.0±0.29[b]	7.9±0.72[b]	7.9±0.29[c]	7.8±0.18[b]
C	7.9±0.47[b]	7.4±0.96[b]	7.8±0.18[b]	8.0±0.17[b]	7.7±0.31[c]	7.8±0.64[b]
D	7.7±0.39[b]	7.2±0.31[b]	8.2±0.17[c]	8.2±0.33[c]	7.2±0.57[b]	7.7±0.49[b]
E	7.7±0.68[b]	7.0±0.18[b]	8.3±0.34[c]	8.2±0.24[c]	7.1±0.48[b]	7.9±0.13[b]
F	6.2±0.31[a]	6.1±0.64[a]	6.3±0.27[a]	7.0±0.68[a]	6.5±0.33[a]	6.6±0.10[a]

Note: The values are mean ± SD (n = 10). Values with similar superscripts in a column do not differ significantly ($p<0.05$), A = Control; B = 95 RWF: 5 CH; C = 90 RWF:10 CH; D = 85 RWF:15 CH; E = 80 RWF:20 CH; F = 75 RWF:25 CH, RWF Refined wheat flour; CH Chickpea Husk.

Table 4: Antioxidant Activity of Biscuits

	TPC (mg GAE/100 g)	DPPH (%)	FRAP (mg Ascorbic Acid/100 g)
A	33.76±1.02[e]	40.76±1.64[e]	23.48±1.65[d]
B	45.89±1.25[d]	44.38±1.32[e]	27.15±1.29[d]
C	61.26±1.34[c]	51.96±1.22[d]	31.59±1.13[c]
D	77.48±2.03[b]	68.47±1.09[c]	36.48±1.28[c]
E	83.41±1.87[b]	75.16±2.14[b]	42.76±1.33[b]
F	92.54±1.59[a]	87.44±2.09[a]	48.11±1.51[a]

Note: The values are mean ± SD (n = 3). Values with similar superscripts in a column do not differ significantly ($p<0.05$), A = Control; B = 95 RWF: 5 CH; C = 90 RWF:10 CH; D = 85 RWF:15 CH; E = 80 RWF:20 CH; F = 75 RWF:25 CH, RWF Refined wheat flour; CH Chickpea Husk.

the DPPH radical scavenging activity increased. The DPPH activity increased from 40.76 to 87.44% on 25% incorporation of chickpea husk. The increase in free radical scavenging activity may be attributed to increase in the content of polyphenols through incorporation of chickpea husk. Ferric reducing power increased significantly ($p<0.05$) with increase in level of chickpea husk incorporation. The Ferric reducing power increased from 23.48 to 48.11 mg Ascorbic acid/100 g. The ferric ion reducing properties are related with the presence of reductones, which exert antioxidant action by breaking the free radical chain by donating a hydrogen atom (Shimada *et al.*, 1992).

CONCLUSION

Incorporation of chickpea husk, a by-product of pulse industry, in biscuit formulation showed considerable effects on physico-chemical and sensory properties of biscuits. The results of the study concludes that biscuits withacceptable sensory properties,high antioxidant activity, enhanced protein anddietary fiber content can be developed by incorporating chickpea husk up to a level of 20% in refinedwheat flour. Since, the use of composite flours is the latesttrend in the bakery industry, the use of chickpea husk alongwith refined wheat flour can be exploited successfully in bakeryproducts other than biscuits also.

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