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The effect of chickpea (*Cicer arietinim*) husk on the properties of cracker biscuits

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Abstract

Chickpea (*Cicer arietinim*) husk was extracted by non-alkaline aqueous extraction process. The residual extracted husk was dried in a cabinet drier and finally ground. Both fresh husk and processed husk were analyzed for their composition. The processed husk (extracted ground husk) was incorporated into formulations of cracker biscuits at 0-20% replacement levels of wheat flour and baking functionalities were evaluated. The studies on the effects of processed husk on biscuit's qualities showed that the highest spread ratio of biscuits was achieved with 3% processed husk. Analysis of cracker biscuits containing various percentage of processed husk showed that biscuits with increasing level of processed husk had higher ash, fat, moisture and crude fiber content, while lower protein and total carbohydrate content. The amount of crude fiber content of biscuits significantly increased with the incorporation of processed husk when compared with conventional biscuits. The cracker biscuits containing various percentages of processed husks were evaluated for their sensory attributes. The results revealed that cracker biscuits containing 5% processed husk secured the highest score for overall acceptability among other substitution levels.

Keywords: Chickpea husk, Cracker biscuits, Crude fiber, Baking properties

Introduction

Legume husks (also called legume hulls, pulse hulls or pulse husks), a by-product of dhal (pulse) milling industries, are being used mainly for animal feed. The most important legumes grown in Bangladesh include chickpea, lentil, peas, soybeans, black gram, green gram, red gram, lathyrus, cowpea etc. Among those, Chickpea (*Cicer arietinim*) commonly known as gram, is third major pulse crop of Bangladesh, after Khesari and Lentil. The estimated total production of legume in Bangladesh is about 3, 32,890 tons and occupies 10,39,705 acre area (BBS, 2004).Apart from this, a significant amount of legumes is imported every year. The legume husk is rich in dietary fiber constituting about 27-47% crude fiber and 47-60% N-free extract. The dietary fiber includes various components such as cellulose, hemicelluloses, lignin, gums, pectic substances, mucilages etc. The legume husks constitute 9-16% of the total weight of the legume grains. Legumes husks contain protein (4-15%), calcium, phosphorus and iron.

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 placed upon various cereal brans, legume husks and other potential sources of dietary fiber in the formulation of food products. Dietary fiber recently gains tremendous importance in human nutrition, a low intake of which has been linked with such diseases as diverticula's disease, cancer of the colon and rectum, appendicitis, varicose veins and hemorrhoids, coronary heart diseases, gallstone, and diabetes mellitus (Burkitt and Trowell, 1975).

Dietary fiber (alternate names: roughage, bulk, diet-fiber) is a complex of substances of cell walls of plants which are not digested and absorbed in a human's digestive tract. Part of it, however, may be metabolized by bacteria in the lower gut. It is a mixture of substances of polysaccharide character (cellulose, hemicelluloses, pectins, gums, mucilages) and non-polysaccharide one (lignins).Dietary fiber is found only in plant foods: fruits, vegetables, nuts and grains. With the above points into consideration the present study was undertaken to evaluate the various baking functionality of the prepared cracker biscuits and the effects of processed husk on the dietary fiber content of` cracker biscuits.

Materials and Methods

Chickpea husk: Chickpea husk from chickpea (Bengal-gram) was obtained from a local dhal mill. In order to make the husk free from sand and extraneous matter, the husk was sieved on 80 mesh sieve before use. Throughout the study this husk is termed as 'Raw chickpea husk'. For comparative study, a sample of ground raw husk also prepared by grinding the dried raw husk in a dhal mill to pass through 72 mesh sieve, packed in polyethylene bags and called 'Extracted Ground husk'.

Preparation of aqueous extracted chickpea husk: The method of Robert *et al.* (1985) was used to prepare extracted chickpea husk. The chickpea husks were suspended in 10 volumes of tap water (pH 6.70) in a flask and agitated at high speed on a horizontal flask shaker for 16 hr at room temperature (25-30^{0}c). The resulting suspension was separated from extracted residual husk through cloth. The residual husk (called extracted husk) was washed five times with water. The extracted husk was then dried in a cabinet drier on stainless steel trays for 4.5 hr at 90^0 C. After cooling to room temperature, the dried extracted husk were thoroughly mixed and packed in double layered polyethylene bags. A sample of extracted husk was ground to powder in flour mill, packed in polyethylene bags and called “Ground Extracted Husk”.

Chemical analysis of raw chickpea husk, ground chickpea husk and biscuits: The raw chickpea husk, ground chickpea husk and biscuits prepared by incorporating ground husk were analyzed for their moisture, protein, ash, crude fat, crude fiber and total carbohydrate contents. The moisture, protein and ash contents were determined as per the standard methods of AOAC (2000). The carbohydrate contents were determined as total carbohydrate by difference that is by subtracting the measured protein, fat, ash and moisture from 100 (Pearson, 1976).

Formulation of cracker biscuits: The basic formulations used for preparation of cracker biscuits are outlined in Table 1.

Table 1. Basic formulation of cracker biscuits

Ingredients in gram	Quantity in gram
Wheat flour *	100
Fat (hydrogenated)	30
Salt (Nacl)	1.5
Water	30
Baking powder	1
Ammonium bicarbonate	0.4

* Wheat flour was replaced with various levels of ground chickpea husk

Procedure for preparation of cracker biscuits: The wheat flour, ground husk and other ingredients were weighed accurately. The preweighted ingredients were mixed. Fat was added into the dry ingredients. Water was added accurately to form dough. The dough was then kneaded and rolled to a uniform thickness of 3 mm. The biscuits were cut out with round biscuits cutter of 3.5 cm diameter. Then the biscuits were baked at 220^{0}C for 10-15 minutes, cooled to ambient temperature and packed in high density polyethylene bags.

Objective evaluation of cracker biscuits: The spread ratio of cracker biscuits was initially used as an important parameter of biscuit quality. The spread ratio was determined by the formula W/T, where W is the average diameter (in cm) and T is the average thickness (in cm) of 5 biscuits. The moisture content of the biscuits was determined as per the methods of AOAC (2000). Weights (g) of the biscuits were also determined.

The effects of various levels of extracted ground husk on the properties of cracker biscuits: For preliminary studies, cracker biscuits were prepared by incorporating 5 and 10% of extracted ground husk in the formulations of the biscuits. Further, the cracker biscuits were also prepared with various levels of extracted ground husk ranging from 0 to 20% in the biscuit formulations. The biscuits were evaluated for their weight, width, thickness, spread ratio and moisture content.

Subjective (sensory) evaluation of biscuits: A sensory evaluation of biscuits containing various levels was evaluated initially for colour, flavour and texture by a panel of 16 panelists. All the panelists were the post graduate students of the Department of Food Technology and Rural Industries and were briefed before evaluation. For statistical analysis of sensory data, the biscuits containing 5, 10 and 15% extracted ground husk along with the control biscuits were further subjected to sensory evaluation. In this case, 9-point hedonic rating test was performed to asses the degree of acceptability of these biscuits. Three pieces from each biscuit lot was presented to 16 panelists as randomly coded samples. The test panelists were asked to rate the sample on a 9-point hedonic scale for colour, flavour, texture and overall acceptability. The results were evaluated by Analysis of Variance and Duncan Multiple range Test (DMRT) procedures of the Statistical Analysis System (SAS, 1985).

Results and Discussion

Composition of raw, extracted unground and ground chickpea husk: The initial raw chickpea husk were analyzed for their moisture, ash, protein, fat, crude fiber and total carbohydrate contents. The analysis showed that the composition of raw chickpea husk as moisture 15.03%, ash 4.79%, protein 5.25%, fat 0.72%, total carbohydrate- a) crude fiber 32.2% and b)others- 42.01%. The extracted unground and ground chickpea husk was also analyzed for their compositions which are presented in Table 2. The moisture contents of extracted ground and unground husk samples were substantially lower than those of raw sample of chickpea husk due to moisture loss during drying and grinding process. The significant reduce in ash content of extracted husk might be resulted from the removal of soluble and suspended solids from the husk during extraction process. The protein content of raw sample of chickpea husk is significantly higher than those of extracted unground and ground samples. Removal of proteins from chickpea pea husk during aqueous extraction process significantly reduced the protein contents in extracted husk. The extracted unground and ground husk had slightly lower fat content compared to raw sample of chickpea husk. The extracted unground and ground husk contained significantly more crude fiber than raw samples due to removal of soluble and suspended solids from the husk during extraction process. The extracted unground and ground husk contained more carbohydrates than raw samples of chickpea husk.

Table 2. Composition of raw, extracted unground and ground chickpea husk

Components (%)		Raw sample of chickpea husk	Extracted unground chickpea husk	Extracted ground chickpea husk
Moisture		15.03	6.32	5.71
Ash		4.79	3.58	3.97
Protein		5.25	4.62	4.94
Fat		0.72	0.60	0.65
Total carbohydrate (by difference)	Crude fiber	32.20	46.60	42.35
	Others	42.01	38.28	42.38

Preliminary studies on the effects of extracted ground chickpea husk on the physical properties of cracker biscuits: The cracker biscuits were prepared by incorporating 0, 5 and 10% of extracted ground chickpea husk in the formulation of the cracker biscuits. The biscuits were evaluated for their weight, width, thickness, spread ratio and moisture content. The results are presented in Table 3.

The weights of all the biscuit samples were higher than the control biscuits containing no processed husk. The weight of biscuits was increased with increasing level of incorporating processed husk. The biscuits containing lower amount of processed husk might have better quality with lighter and less dense texture than the biscuits containing higher amount of processed husk. At 5% substitution level, the biscuits have higher width than 10%. The particle size and amount of processed husk affected the width of biscuits. The larger particles of processed husk than normal wheat flour may have adverse effect to yield lower width of biscuits. The width of all biscuits was lower than that of control biscuits. There was no effect of addition of processed husk on the thickness of the biscuits. The spread ratio is considered as one of the most important quality parameter of biscuits because it correlates with texture, grain finesse, bite and overall mouth feel of the biscuits. The spread ratio was significantly influenced by the addition of processed husk in the biscuit formulation. Spread ratio of control biscuits was higher than those containing 5% and 10% processed husk. Biscuits containing 5% processed husk gave higher spread ratio than biscuits containing 10% processed husk. The finer particles of wheat flour may have beneficial effect on spread ratio of biscuits. As the processed husk increases, the gluten dilution also reduces in flour and processed husk mixture; it may adversely affect the spread ratio of biscuits. The moisture content of all biscuits was higher than that of control biscuit. Moisture content of cracker biscuits increased with the increasing the amount processed husk used in the formulation of cracker biscuit. Similar effects were observed in cracker biscuits containing cassava flour (Shams-Ud-Din and Alim, 2003). This indicates that the larger particles of processed husk have higher water holding capacity than the smaller particles of wheat flour.

Table 3. Effects of extracted ground chickpea husk on the physical properties of cracker biscuits

Biscuit types	Substitution levels for wheat flour (%)	Weight (gm)	Width (W) in cm	Thickness (T) in cm	Spread ratio (W/T)	Moisture content (%)
Control	0	4.04	3.75	0.53	7.08	3.51
Ground husk	5	4.12	3.68	0.53	6.98	3.64
	10	4.17	3.66	0.53	6.91	3.72

The effects of various levels of extracted ground chickpea husk on the quality of cracker biscuits: Cracker biscuits were prepared by incorporation of various levels of extracted ground chickpea husk ranging from 0 to 20% in the biscuit formulation and the biscuits were evaluated for their weight, width, thickness, spread ratio and moisture content. The results are presented in Table 4.

Table 4. Effect of extracted ground chickpea husk at various substitution levels for wheat flour on the weight, width, thickness, spread ratio and moisture content of cracker biscuits

Biscuit types	Substitution level for wheat flour (%)	Weight in gm	Width (W) in cm	Thickness (T) in cm	Spread ratio (W/T)	Moisture content (%)
Control	0	4.04	3.75	0.53	7.08	3.51
Processed husk	3	4.09	3.71	0.53	7.00	3.59
	5	4.12	3.68	0.53	6.94	3.64
	8	4.15	3.67	0.53	6.92	3.69
	10	4.17	3.66	0.53	6.91	3.72
	12	4.20	3.58	0.52	6.88	3.75
	15	4.23	3.55	0.52	6.83	3.80
	20	4.28	3.46	0.52	6.65	3.83

The addition of extracted ground chickpea husk progressively increased the weight and moisture content, while decreased the width and spread ratio of the cracker biscuits. Thickness of the biscuits was more or less similar at 0-20% substitution level. With different levels of processed husk addition from 0-20%, the width of the biscuits progressively decreased up to 20% substitution level. The width of all the biscuit samples was lower than that of control biscuit. With different levels of processed husk addition from 0-20%, the weight of the biscuits progressively increased up to 20% substitution level. The weight of all the biscuit samples was higher than that of control biscuit. The increase of biscuit's weight may result from the increased water absorption by the higher level of processed husk. The spread ratio of biscuit is the most important quality parameter. The spread ratio of all biscuit samples gradually decreased with increasing the addition of processed husk. The moisture content of all biscuit samples gradually increased with increasing the addition of processed husk. This indicates that the larger particles have higher water holding capacity than that of smaller particles. The biscuits containing lower amount of processed husk might have better quality and less dense texture than those higher containing amount of processed husk.

Effect of various level of extracted ground chickpea husk on the composition of cracker biscuits: Cracker biscuits were prepared by incorporating various level of processed husk and analyzed their composition. The results were presented in Table 5.

Addition of ground chickpea husk affected the composition of cracker biscuits. With the increasing level of processed husk, increased the level of moisture, ash, fat and crude fiber but decreased the level of protein and total carbohydrate. Analysis of some Bangladeshi cracker type (7 brands) biscuits has been reported by Kabirullaha *et al.* (1995). These authors reported that moisture content 3.04-5.60%, ash 1.09-2.14%, fat 8.20-26.67%, protein 7.91-7.40%, carbohydrate 59.94-78.08%. In present study it was observed that moisture, ash, protein, fat and total carbohydrate were more or less similar to the reported by Kabirullah *et al.* (1995). In this study also observed that control biscuit (without processed husk) contained 1.67% crude fiber, whereas biscuit containing 5% ground chickpea husk contained 4.25% crude fiber, biscuit containing 10% ground chickpea husk contained 9.40% crude fiber and biscuit containing 15% ground chickpea husk contained 17.9% crude fiber. Then, it was concluded that, increased the level of crude fiber with the increasing the amount of incorporated processed husk.

Table 5. Composition of cracker biscuits containing processed husk

Components (in%)		Control biscuit (witout processed husk)	Biscuit containing 5% processed husk	Biscuit containing 10% processed husk	Biscuit containing 15% processed husk
Moisture		3.51	3.64	3.72	3.80
Ash		1.60	1.65	1.80	2.14
Protein		9.72	9.63	9.01	8.92
Fat		21.90	22.80	23.34	23.56
Total Carbohydrate (by difference)	Crude fiber	1.67	4.25	9.40	17.90
	Others	61.60	58.03	52.73	43.68

Statistical sensory evaluation of cracker biscuits: Cracker biscuit containing 0, 5, 10 and 15% extracted ground chickpea husk were subjected to sensory evaluation by a panel of 16 panelists. The mean scores for color, flavor texture and preferences of overall acceptability of biscuits were presented in Table 6. A two way analysis of variance indicated that these sensory attributes of the cracker biscuits were significantly affected ($P<0.05$) by addition of different levels of processed husk in biscuit formulations. The Duncan's Multiple Test (DMRT) revealed that the control biscuit scored highest for colour than the biscuits containing processed husk. As shown in Table 6, there was no significant difference in colour preference between the biscuits containing 5% and 10% extracted ground chickpea husk and also no significant difference between the biscuits containing 10% and 15% extracted ground chickpea husk. But there was significant difference in colour preference between the biscuits containing 5% and 15% extracted ground chickpea husk. Among the processed husk incorporated biscuits, 5% extracted ground chickpea husk containing biscuit was the most preferred one. The flavour of biscuit containing 5 % extracted ground chickpea husk was significant better than the biscuit containing 10 and 15 % extracted ground chickpea husk respectively. There was no significant difference in colour preference between the biscuits containing 10% and 15% extracted ground chickpea husk. Texture of biscuit containing 5 % extracted ground chickpea husk was most preferred and significantly better than the biscuit containing 10 and 15 % extracted ground chickpea husk. Overall acceptability of the control cracker biscuit was the highest and it was significantly better than those incorporated processed husk.

Table 6. Mean sensory score of cracker biscuits containing processed husk

Biscuit type	Sensory attributes			
	Colour	Flavour	Texture	Overall acceptability
Control (wheat flour only)	8.063^{a}	7.563^{a}	7.875^{a}	7.813^{a}
5% processed husk	7.188^{b}	6.688^{b}	7.000^{b}	6.938^{b}
8% processed husk	6.813^{bc}	6.188^{c}	6.500^{c}	$6.500b^{c}$
12% processed husk	6.500^{c}	6.000^{c}	5.875^{d}	6.188^{c}
L.S.D ($P<0.05$)	0.4637	0.4637	0.4610	0.4817

Among the experimental biscuits, the highest overall acceptability was achieved with 5% extracted ground chickpea husk substituted biscuits followed by 10 and 15 % extracted ground chickpea husk substituted biscuits. Overall acceptability significantly decreased with increasing levels of processed husk in cracker biscuit formulation.

Conclusion

This study has shown that, in general, the spread ratio of cracker biscuits resulted from the replacement of wheat flour with processed husk was found to be quite lower than that of control biscuits (without processed husk). Higher spread ratio was achieved when supplemented with 3% processed husk. Moisture contents of cracker biscuits supplemented with processed husk were higher than those of control biscuits. The addition of increasing levels of processed husk in the cracker biscuits affected the quality attributes. However, considering various baking quality and sensory attributes, it has been found that 5% processed husk could be incorporated in the formulations in order to produce biscuits with acceptable quality.

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