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Physico-Chemical, Baking and Sensory Properties of Chickpea Flour Incorporated Rice Crackers

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ABSTRACT

Present study was conducted to evaluate the effect of incorporation of chickpea flour on nutritional, sensory, texture and baking quality of rice crackers. The study showed that incorporation of chickpea flour resulted in increase in the moisture, fat, ash, protein, fibre and dietry fibre of rice crackers. Moreover, there was decrease in thickness, volume index, hardness and density of the rice crackers with increased level of chickpea flour. While as, diameter and spread ratio were reported to increase. Fortification with different levels of chickpea flour had a positive influence on sensory attributes of rice crackers. All the products were found to be acceptable as recorded by the penalists in terms of colour, texture, appearance and overall acceptability.

Keywords: Rice, chickpea, hardness, sensory, etc.

I.INTRODUCTION

Celiac disease also called as gluten sensitive enteropathy is a chronic disorder of the small intestines which is characterized by a strong immune response to certain amino acid sequences found in the prolamin fractions of wheat, barley and rye (Hill *et al*., 2005). When people with celiac disease eat foods containing gluten, their immune system responds by damaging or destroying the intestinal villi leading to the malabsorption of nutrients, thus adversely affecting all systems of the body (Feighery, 1999). The gluten-free diet remains until now the only treatment for Celiac disease. Rice flour is one of the most suitable cereal flour for development of gluten-free products because it has a low level of prolamin. Besides, rice possesses unique nutritional, hypoallergenic, colorless, and bland taste properties (Sanchez *et al*., 2002).

Mixing two or more different materials will help to solve the deficiency problem associated with consumption of cereals such as by using legumes as source of protein to supplement the nutritional value of cereal based products. Legumes such as chickpea are high in nutrient especially in protein (18-24%) than cereal grain. Furthermore, legume proteins are rich in lysine but deficient in sulphur-containing amino acids, whereas cereal proteins are deficient in lysine but have adequate levels of sulphur containing amino acids. The combination of cereal and legume proteins would thus provide a better overall balance of essential amino acids, which is very important in a balances diet (De la Hera *et al.*, 2012; Kadam *et al.*, 2012). In addition, the inclusion of legumes

in the daily diet has many beneficial physiological effects in controlling and preventing various metabolic diseases such as diabetes mellitus, cardiovascular disease and some forms of cancer (Kohajdova *et al.*, 2013).

Presend study was carried out to evaluate the effect of replacement wheat flour by 100% of rice flour and its supplemtation by different levels of extruded chickpea flour on the nutritional, sensory, hardness and baking quality of produced crackers.

II. MATERIAL AND METHODS

- **Raw material**

Raw materials (Chickpea var. SKUAST-233 and Rice var. Jhelum) were procured from SKUAST-Kashmir, Shalimar, India.

- **Preparation of material for extrusion**

The moisture content of the chickpea flour was measured before extrusion. Samples were prepared by adding calculated amount of distilled water to obtain the different desired moisture levels as per the experimental design. Flours were sealed in polyethylene bags and allowed to equilibrate for 24 hours before extrusion.

Extrusion experiment was performed in a co-rotating twin screw extruder (Basic Extrusion Technology Pvt. Ltd., Kolkatta, India) at Division of PHT, SKUAST-K, Shalimar. Extrusion conditions were 20 percent moisture, 180°C barrel temperature and 303 rpm screw speed, respectively.

- **Procedure for preparation of cracker**

Rice crackers were prepared by following the standard procedures of AACC (2000). The proportion of rice flour and extruded chickpea flours was varied; T_1 (100 % rice flour), T_2 (95:5), T_3 (90:10), T_4 (85:15) and T^5 (80:20). The gluten free crackers were analyzed in term of nutritional, sensory and baking properties.

- **Proximate composition**

The moisture, ash, fat, crude protein (% N x 6.25) and crude fibre of the samples were determined by the AOAC method (2000).

- **Texture**

Hardness of crackers was evaluated by following the procedures as described by Majzoobi *et al*. (2014 using a Texture Analyser (TA-XT2, Stable Micro System Ltd., Surrey, UK) which was interfaced with a computer to control the instruments and analyze the data. Crackers were placed on the platform of the Texture Analyser. An aluminum cylindrical probe of the diameter of 80 mm was made use of in a ‘‘Texture Profile Analysis’’ (TPA) test to compress the samples to 25% depth, at a pretest speed of 5 mm s^{-1}, test speed of 0.25 mm s^{-1} and time interval of 10 seconds.

- **Baking quality of crackers.**

Spread ratio (W/T). Spread ratio of untreated and treated rice crackers was determined according to the equation (1) given below;

$$Spread\ ratio = \frac{W}{T} \quad \text{---------- (1)}$$

where, W is the average diameter (width in mm) and T is the average thickness (in mm) of crackers (AACC, 2000; Bose and Shams-Ud-Din, 2010; Kohajdová *et al*., 2011).

Percentage puffiness (%). Percentage puffiness was determined by following the methods as described by Nammakuna *et al*. (2009). Percentage puffiness was calculated according to the equation (2) given below;

$$\text{Percentage puffiness } (\%) = \frac{\text{Thickness of baked cracker} - \text{Thickness of cracker dough}}{\text{Thickness of cracker dough}} \times 100$$

--- (2)

The thickness of cracker before and after baking was determined by a digital Vernier caliper.

Bulk density (g/mL). The bulk density of crackers was determined by volumetric method. The volume of the expanded sample was measured by using a 25 mL graduated cylinder and gently tapped for 5 times. The volume of 10 g randomized samples was measured for each test. The ratio of sample weight and the replaced volume in the cylinder was calculated as bulk density (w/v) (Pan *et al*., 1998; Bhise *et al*., 2013).

$$Bulk\ density\ \left(\frac{g}{mL}\right) = \frac{Weight\ of\ sample}{Volume\ displaced\ by\ sample} \quad \text{------ (3)}$$

Volume index. Volume index was determined by following the standard procedures as described by Shyam and Raghuvanshi (2013).

Thickness (mm). The thickness of cakes was measured by placing six crackers on the top of each other, followed by a duplicate reading recorded by shuffling biscuits (Ahmed and Hussein, 2014).

Diameter (mm). The diameter of crackers was measured by placing 6 edge-to-edges horizontally and rotating 90^o angle for a duplicate reading (Ahmed and Hussein, 2014).

Yield (%). Yield of rice crackers was determined using the equation (4);

$$Yield\ (\%) = \frac{Weight\ of\ dough}{Weight\ of\ crackers} \times 100 \text{ ------- (4)}.$$

Sensory evaluation: rice crackers were evaluated for the following sensory attributes through a panel of semi-trained judges using 5-point scale:

a. Appearance
b. Color
c. Hardness
d. Aroma
e. Overall acceptance

Result and Discussion

Proximate composition

The effect of incorporation of extruded chickpea flour on the hardness of rice crackers is presented in Table 1. Results from table 1 indicate that composition of the rice crackers was significantly ($p \leq 0.05$) affected by increased addition of extruded chickpea flour. Moisture, fat, protein, ash, fibre and dietary fibre increased from 4.84 to 5.30 %, 12.78 to 14.72 %, 6.95 to 8.28 %, 1.57 to 2.57 % 1.15 to 2.19 % and 1.55 to 2.48 where as

carbohydrate content decreased from 77.55 to 72.24, respectively. Similar trend has been reported by Bose and Shams-Ud-Din (2010)

III. HARDNESS

The effect of incorporation of extruded chickpea flour on the hardness of rice crackers is presented in Table 2. Results from table 2 indicate that hardness of the rice crackers was significantly ($p \leq 0.05$) affected by increased addition of extruded chickpea flour. Hardness of crackers ranged from 12.33 to 14.87 N and decreased significantly ($p \leq 0.05$) with incorporation of extruded chickpea flour. Lowest value (12.33N) of hardness was recorded in crackers containing 20 per cent extruded chickpea flour (T_5) and highest (14.87 N) in control (T_1). Mancebo et al. (2016) observed decreased hardness when proteins were added to cookies. Hadnadev et al. (2011) who substituted rice flour with buckwheat flour with higher protein content also reported reduction in hardness of cookies containing higher levels of buckwheat flour.

IV.BAKING QUALITY

The effect of incorporation of extruded chickpea flour on the baking quality of rice crackers is presented in Table 2.

Results pertaining to the effect of incorporation of extruded chickpea flour on the baking quality of rice crackers indicate that baking properties of crackers from 100 per cent rice flour were significantly ($p \leq 0.05$) different from the crackers made from composite flours (rice flour and chickpea flour). Thickness, volume index and bulk density of crackers decreased with the increasing addition of chickpea flour while as diameter and spread ratio increased. However, the effect of incorporation of chickpea flour on yield of rice crackers was not significant ($p \leq 0.05$). The results are in agreement with those reported by Igbabul et al. (2015) who have also reported decrease in the thickness and increase in diameter of wheat cookies incorporated with cocoyam and African bean flours and have attributed this decrease in thickness of cookies to increased protein content from added flours. Similar decrease in volume index was also described in study of Gómez et al. (2008) for cakes incorporated with various levels of chickpea flour.

V.ORGANOLEPTIC EVALUATION OF CHICKPEA INCORPORATED RICE CRACKERS

Table 3, depicts organoleptic evaluation results of chickpea incorporated rice crackers. Perusal of the data indicated that addition of extruded chickpea flour exhibited significant ($p \leq 0.05$) influence on appearance, colour, hardness, aroma and overall acceptability of rice crackers. Results from table 3 revealed that rice crackers developed at 20 per cent level of extruded chickpea flour incorporation (T_5) recorded highest acceptability score for appearance (4.27), colour (4.05), hardness (3.57), arroma (3.25) and overall acceptability (3.78) out of maximum 5 point scale applied for organoleptic evaluation. However, lowest score for sensory parameters varied amongst treatments. Crackers containing 15 per cent extruded chickpea flour (T_4) recorded

lowest acceptability score for appearance (2.62) and colour (2.63), whereas control (T_1) recorded lowest value for overall acceptability (2.76), control and crackers containing 15 per cent extruded chickpea flour (T_4) recorded similar values for hardness (2.60) and aroma (2.58), respectively. Vongsumran et al. (2014) have also reported higher liking scores on odor and flavor of dough nut cakes made from all cooked bean flours than those made from raw legumes flour. Gomes et al. (2013) reported that development of gluten free cakes is feasible with upto 75% of extruded bean flours.

VI. CONCLUSION

From this study it can be concluded that the replacement of wheat flour by rice flour and subsequent addition of chickpea flour up to 20 % to rice flour can be followed without any adverse effect on nutritional, baking and sensory characteristics of rice crackers. Chickpea flour incorporation significantly improved composition, baking and sensory characteristics of crackers. Therefore, a re-design of the gluten free bakery goods is needed for obtaining gluten free baked products with similar nutritional composition to that of their gluten counterparts. Those products would allow celiac patients and/or population with other allergic reactions and intolerances caused by proteins or another component of cereals to meet dietary guidelines without changing their dietary pattern.

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TREATMENT	Moisture (%)	Crude Fat (%)	Crude protein (%)	Crude fibre (%)	Ash (%)	Carbohyd-rates (%)	Dietary fibre (%)
T_1 : 100 % RF	4.91[a]	12.78[a]	6.95[a]	1.15[a]	1.57[a]	77.55[a]	1.55[a]
T_2 : 95 % RF + 5% CPF	4.84[b]	13.22[b]	7.25[b]	1.36[b]	1.81[b]	76.36[b]	1.84[b]
T_3 : 90 % RF + 10 % CPF	5.03[c]	13.78[c]	7.68[c]	1.72[c]	2.03[c]	74.79[c]	2.01[c]
T_4 : 85 % RF + 15 % CPF	5.18[d]	14.23[d]	7.93[d]	1.94[d]	2.31[d]	73.59[d]	2.28[d]
T_5 : 80 % RF + 20 % CPF	5.30[e]	14.72[e]	8.28[e]	2.19	2.57[e]	72.24[e]	2.48[e]

Tables and figures

Table no. 1. Effect of chickpea flour incorporation on physicochemical composition of rice crackers

RF: rice flour; CPF : chickpea flour

Values with different superscripts within the column are statistically significant

TREATMENT	Hardness (N)	Thickness (mm)	Width (mm)	Spread ratio	Puffiness (%)	Volume index	Bulk density (g/ml)	Yield (%)
T_1 : 100 % RF	14.87[a]	0.80[a]	2.34[a]	2.92[a]	3.41[a]	1.72[a]	0.68[a]	76.20
T_2 : 95 % RF + 5% CPF	14.82[b]	0.75[b]	2.40[b]	3.20[b]	4.30[b]	1.64[b]	0.67[a]	76.23
T_3 : 90 % RF + 10 % CPF	14.48[c]	0.73[c]	2.35[a]	3.22[b]	6.02[c]	1.60[c]	0.67[a]	76.23
T_4 : 85 % RF + 15 % CPF	13.94[d]	0.69[d]	2.45[c]	3.55[c]	8.04[d]	1.58[d]	0.65[b]	76.35
T_5 : 80 % RF + 20 % CPF	12.33[e]	0.65[e]	2.50[d]	3.84[d]	10.30[e]	1.57[e]	0.63[c]	75.92

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Table no. 2. Effect of chickpea flour incorporation on hardness and baking quality of rice crackers

RF: rice flour; CPF : chickpea flour

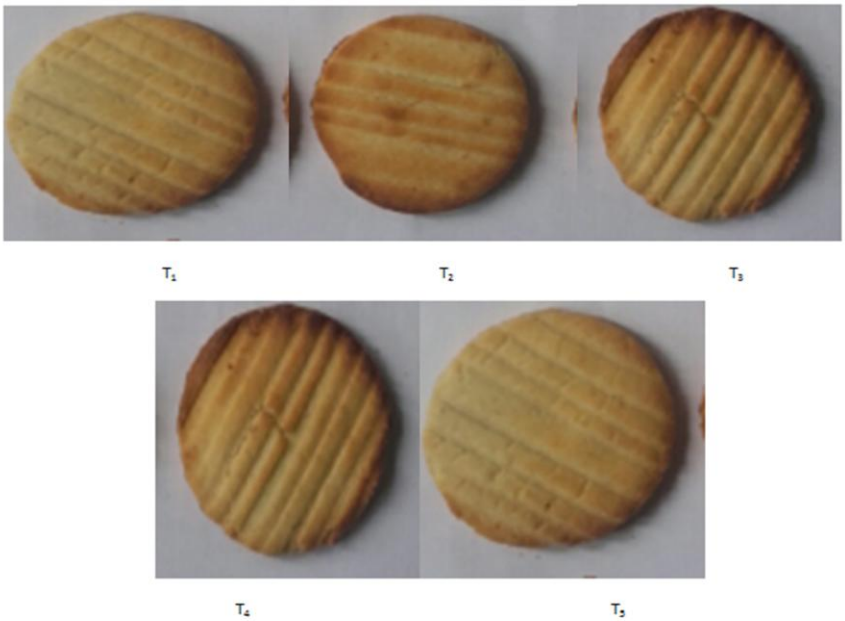
Values with different superscripts within the column are statistically significant

Table 3: Organoleptic evaluation (5-point scale) of chickpea incorporated rice crackers

TREATMENT	Appearance	Color	Hardness	Aroma	Overall acceptability
T_1 : 100 % RF	2.95^a	2.90^a	2.60^a	2.58^a	2.76^a
T_2 : 95 % RF + 5% CPF	3.62^b	3.80^b	3.02^b	2.65^b	3.27^b
T_3 : 90 % RF + 10 % CPF	2.87^c	2.95^c	3.10^c	2.50^c	2.86^c
T_4 : 85 % RF + 15 % CPF	2.62^d	2.63^d	2.60^d	2.58^d	3.01^d
T_5 : 80 % RF + 20 % CPF	4.27^e	4.05^e	3.57^e	3.25^e	3.78^e

RF: rice flour; CPF : chickpea flour

Values with different superscripts within the column are statistically significant



T_1 = 100 % rice flour; T_2 = 95% rice flour +5% extruded chickpea flour; T_3= 90% rice flour +10% extruded chickpea flour; T_4 = 85% rice flour +15% extruded chickpea flour; T_5 = 80% rice flour +20 % extruded chickpea flour

Fig. 1. Chickpea incorporated rice crackers