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## Development and Storage Study of Maize and Chickpea Based Extruded Snacks

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### ABSTRACT

#### Keywords

Extrusion, Maize, Chickpea, Snacks, Overall acceptability, Storage.

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The present investigation was undertaken to explore the potentiality of maize and chickpea for the development of extruded products as there is an increasing consumer demand for more nutritious snacks. Maize and chickpea are good source protein and crude fiber. Maize and chickpea in different ratio (100:0, 95:5, 90:10, 85:15, 80:20, 75:25, 70:30, 65:35, 60:40) were blended in and subjected to extrusion by co-rotating twin screw extruder. On the basis on sensory evaluation 80:20 ratio blend of maize and chickpea was selected for further study. The selected products were stored for three months and evaluated for free fatty acid, moisture, hardness and sensory characteristics. With the progress in the storage period moisture and free fatty acid of snacks increased while hardness of snacks decreased with progress in storage. However, snacks were found acceptable at the end of three months.

### Introduction

Convenience foods (snack foods) have become an integral part of the daily food intake of the majority of the world's population. Properly designed convenience foods can make an important contribution to nutrition in societies where social changes are altering traditional patterns of food preparation. Basically, these are prepared from natural ingredients or components according to predesigned plans to produce products with specified quality (Limsangouan *et al.*, 2009).

The most widely consumed extruded snacks are prepared primarily with cereals/grains due

to their good expansion characteristics; however, their nutritional value is far from satisfying the needs of health-conscious consumers (Rampersad *et al.*, 2003). Hence, there is an increasing consumer demand for more nutritious snacks (Agriculture and Agri-Food Canada, 2008). Several attempts to improve the nutritional profile of extruded starch have been reported (Liu *et al.*, 2000; Rampersad *et al.*, 2003). Among other materials, incorporation of legume flours has been shown to cause a positive impact on levels of proteins and dietary fibre of cereal based extruded snacks (Berrios, 2006). On the other hand, addition of high-fibre, high-

protein alternate ingredients to starch has been demonstrated to significantly affect the texture, expansion and overall acceptability of extruded snacks (Liu *et al.*, 2000; Veronica *et al.*, 2006). For the production of nutritious acceptable snacks, rates of starch fortification seem to vary according to the nature of each material. Legumes, for example, have been reported to cause good expansion and are regarded as highly feasible for the development of high-nutritional, low-calorie snacks (Berrios, 2006).

Maize or corn (*Zea mays*) is the third most important food grain after wheat and rice which belongs to the grasses family. In India, 28% maize is used for food purpose, 11% as livestock feed, 48% as poultry feed, 12% in wet milling industry and 1% as seed (AICRP 2007). On the other hand, chickpea (*Cicer arietinum*) is the third most important legume in the world after dry beans and dry peas. It is highly nutritious and do not contain any major anti-nutritional factors and may provide potential health benefits including reduced risk of cardiovascular disease, cancer, diabetes, osteoporosis, hypertension, gastrointestinal disorders, adrenal disease and reduction of LDL cholesterol (Hu 2003; Philanto and Korhonen 2003).

Extrusion cooking technology is a high-temperature short time process that converts agricultural commodities, usually in a granular or powdered form, into fully cooked, shelf-stable food products with enhanced textural attributes and flavor. Due to the processing flexibility offered by extrusion cooking technology, it has become a cornerstone of the food industry, primarily in the cereal, dairy, bakery, confectionery and pet food industries (Patil *et al.*, 2007). It permits preparation of ready-to-eat nutritious foods with desirable taste, flavor and texture. The importance of nutritious foods has been well recognized and several health foods has

been produced and marketed in India and abroad. However, most of the proprietary nutritious foods are expensive and priced beyond the reach of the population of the middle and lower economic class. Hence preparation of low-cost nutritious foods is highly desirable and extrusion technology has been successfully applied for this purpose. Therefore the present investigation was carried out to optimize the ratio of maize and chickpea for the development of extruded snacks and to assess storage stability of prepared product.

## **Materials and Methods**

### **Material**

Maize (variety PMH-1) and chickpea (variety PBG 5) procured from the Department of Plant Breeding and Genetics, PAU, Ludhiana were used for the study. Salt used in final product preparation was mixture of salt (2 %). Salt procured from the local market.

### **Physicochemical composition of raw grains**

Physico-chemical characteristics of maize and chickpea flour were determined using standard methods (AACC, 2000).

### **Moisture content**

Weighed samples (2 g) were dried in a hot air oven at  $130 \pm 1^\circ\text{C}$  for 1 hr. and moisture content in percent was calculated from loss of weight.

### **Crude protein**

Macro-kjeldhal method was used to determine nitrogen and conversion factor of 5.95 and 6.25 was used for maize and chickpea crude protein estimation. 1g sample was digested in Kjeldhal flask with digestion mixture (copper sulphate and potassium sulphate in 1:9 ratio)

and concentrated H<sub>2</sub>SO<sub>4</sub> (20 ml) till light green colour appeared and finally cooled. Ammonia released by distillation of digested samples with saturated NaOH (80 ml) was captured in 0.1 N HCl and percent N was estimated. The protein content was calculated as per cent nitrogen × factor.

### **Crude fat**

Fat analysis of samples was carried out using Soxtec 2045 (Foss instrument, Sweden). Extraction cups were dried in oven at 130°C for 15 min and the weight of empty cups was noted. Weighed sample (3 g) was taken in thimble. Dried empty cups were cooled and 70 ml of petroleum ether was added. Switched on and preheated the instrument, When temperature was attained, the extraction cups were attached to the instrument and left it boiling for 30 minutes, followed by rinsing for 20 minutes and last of all recovery of the solvent was done for 10 minutes. The recovered ether was collected and the fat contained in extraction cups was estimated.

### **Ash**

Weighed (5 g) sample was first incinerated on hot plate until there were no more fumes. It was kept in a muffle furnace at 550 °C for 5 hours, weighed and results were expressed in per cent (AACC 2000).

### **Crude fibre**

Crude fibre of maize and chickpea were estimated using Fibertec (Foss instrument, Sweden). Switch on the instrument to pre-heat the hot plate. Capsules were kept in hot air oven at 100°C for 20 minutes for drying. Cooled pre-weighed and noted down the weight of dried empty capsules and weighed (1 g) sample in capsules (Defatting of samples was done if necessary). Fixed the capsules in

the rotating stand, added 250-275 ml of 1.25 per cent H<sub>2</sub>SO<sub>4</sub> to the large extraction cup and immersed the stand into the beaker. Acid extraction was done by boiling it for 30-40 minutes followed by its washing with hot water. Then alkali washing was done with 1.25 per cent NaOH for the same time duration followed by hot water washing. Finally, capsules were dried in oven for 2 hours at 130 °C and then placed at 550 °C for 5 hours. Cooled and weighed for crude fibre estimation (AOAC 2000).

### **Carbohydrate**

Per cent carbohydrate was determined by subtracting other constituents. Carbohydrates = 100 - (Moisture + Protein + Fat + Ash + Fibre).

### **Sample preparation**

Maize and chickpea was ground into flour using Lab scale super mill 3303 (Perten instrument AB, Sweden) and passed through 200 µm sieves to get a uniform size particles.

### **Extruder and processing conditions**

Extrusion experiments were performed on a co-rotating intermeshing twin screw extruder (Cletral, Firminy, France). The barrel diameter and its length to diameter ratio (L/D) were 2.5 mm and 16:1, respectively. The extruder barrel is divided into four zones. Temperatures of the first, second and third zone was maintained at 40°, 70° and 100°C throughout the experiments, while the temperature at the fourth zone was 160°C. The die plate had one circular hole with 6 mm diameter. The extruder was powered by an 8.5 kw motor with speeds variable from 0 to 682 rpm. The extruder was equipped with a torque indicator, which showed percent of torque in proportion to the current drawn by the drive motor. Raw materials were metered

into the extruder with a single screw volumetric feeder (D S and M, Modena, Italy). The feed rate was varied for optimum fill according to screw speed. The moisture content of the feed was adjusted by injecting water (approximately 30°C) into the extruder with a pump. A variable speed die face cutter with four bladed knives was used to cut the extrudates.

### Storage studies

Optimized product obtained after process optimization were used for shelf-life study. HDPE (200 guage) bags were used for storage of samples at room temperature conditions over a period of 3 months and the product was evaluated for moisture content, free fatty acids, hardness, and overall acceptability, at an interval of one month, during the storage period.

### Free Fatty Acids

Standard AOAC procedure (Anon 2001) was followed with slight modification. Weighed (5 g) sample was taken in flask. 50 ml benzene was added and it was kept for 30 min. for extraction of free fatty acid 5 ml extract was taken in flask, 5 ml benzene, 10 ml alcohol and 2 drops of phenolphthalein solution was added and titrated against 0.02N KOH till light pink colour disappeared.

$$\text{FFA (per cent)} = \frac{282 \times 0.02\text{N KOH} \times \text{ml. of alkali used} \times \text{dilution factor}}{1000 \times \text{Weight of sample taken}}$$

### Results and Discussion

#### Proximate composition of flour

The proximate composition of raw material is given in table 1. The data given in Table 4.1 depicts the proximate chemical composition

of maize and chickpea flour. Maize flour (var PMH-1) contains 9.6 per cent moisture, 1.1 per cent crude ash, 9.9 per cent crude protein, 6.8 per cent fat, 1.9 per cent crude fibre, 71.2 per cent carbohydrates. Ullah *et al.*, (2010) reported that in maize the moisture content in the range of 9.201-10.908%, ash (0.7-1.3%), fats (3.21-7.71%), protein (7.71-14.60%), crude fiber (0.80-2.32%) and carbohydrates (69.659-74.549%). Chickpea flour (PBG 5) contains 7.9 per cent moisture, 24.2 per cent crude protein, 3.4 per cent fat, 3.5 per cent ash, 11.7 per cent crude fibre, 49.3 per cent carbohydrates. Sánchez-Vioque *et al.*, (1999) observed that the chickpea flour contains 8.1±0.1 moisture, 3.7±0.1 ash, 18.8±2.0 fibre, 24.7±1.7 protein, 1.5±0.3 lipids and 51.3±5.5 carbohydrates, grams per 100 gram of dry matter.

### Preliminary trial

Maize flour and chickpea were blended in the ratio of 100:0, 95:5, 90:10, 85:15, 80:20, 75:25, 70:30, 65:35, 60:40 and subjected to extrusion cooking at 15 per cent moisture, 500 rpm screw speed and 160°C temperature. The samples were subjected to sensory evaluation. The extruded snacks were evaluated organoleptically and best combination was further used for optimization. Extruded snacks were evaluated for sensory attributes (appearance, texture, flavour and overall acceptability) through a panel of six semi-trained judges using 9-point hedonic scale (Larmond, 1970). The Table 3 depicts the sensory evaluation data of extruded snacks having different combinations of maize and chickpea level. Extruded product prepared at 80 percent of maize and 20 percent chickpea achieved best sensory score. Keeping in view the sensory quality and nutritional importance of chickpea, the blend of maize flour and chickpea flour with 80:20 ratios was selected for further study.

**Table.1** Proximate chemical composition of maize and chickpea flour

Types of flour	Moisture (%)	Crude protein (%)	Fat (%)	Ash (%)	Crude Fibre (%)	Carbohydrates (%)
Maize	9.6	9.9	6.8	1.1	1.9	71.2
Chickpea	7.9	24.2	3.4	3.5	11.7	49.3

**Table.2** Optimization of maize and chickpea ratio for development of snacks

Maize: Chickpea	Appearance	Texture	Flavor	Overall Acceptability
100:0	8.4	7.8	8.0	8.06
95:05	8.2	7.9	7.8	7.96
90:10	8.1	7.9	7.9	7.96
85:15	8.0	7.8	7.9	7.90
80:20	8.0	8.0	7.8	7.93
75:25	7.8	7.6	7.7	7.70
70:30	7.7	7.4	7.5	7.53
65:35	7.7	7.5	7.0	7.4
60:40	7.0	6.0	7.5	6.83

**Table.3** Effect of storage period on Moisture content (%), Free Fatty Acids (%), Hardness and Overall Acceptability of snacks (n=3)

Storage period (months)	Moisture (%)	Free Fatty Acids (%)	Hardness (N)
0	5.80	0.245	90.7
1	6.10	0.439	88.5
2	6.69	0.572	84.3
3	7.37	0.615	79.7

**Table.4** Effect of storage period on the sensory characteristics of extruded snacks (n=9)

Storage period (months)	Appearance	Texture	Flavor	Overall Acceptability
0	8.4	7.8	8.0	7.66
1	7.2	7.4	7.7	7.43
2	7.1	7.3	7.8	7.40
3	7.1	6.9	7.0	7.00

**Table.5** Cost of production of snacks

Requirements	Cost per kg (in rupees)
Raw material	38
Milling	08
Extrusion	30
Packaging	10
Labour	10
Final cost	96

### Storage study of snacks

Table 3 presents the effect of storage on the moisture content, free fatty acids and hardness of snacks. An increase in moisture content was noticed after a storage period of 3 months which was obvious due to the hygroscopic nature of the snacks. Initially moisture content was 5.80 per cent, increased up to the 7.37 per cent at the end of 3 months storage. Charunuch *et al.*, (2008) reported that there was increased in moisture content observed in Thai rice extruded snack supplemented with mulberry from 3.5 to 5 per cent during storage of 4 months and acceptability of snacks were not much affected at the 3<sup>rd</sup> month of storage. The free fatty acids (per cent) for extruded snacks increased significantly, but remained in the acceptable range during the storage period of 3 months. The hardness of the extrudates decreased from 90.7 to 79.7 N after a storage period of 3 months. Charunuch *et al.*, (2008) also reported a decrease in hardness of iron fortified extrudate Thai rice snacks from 21.38 to 19.44 N.

Table 4 shows the sensory scores of the extruded snacks during 3 months of storage. Highest scores for appearance in extruded snacks were 8.4 which decreased to 7.1 after 3 months of storage. Similarly, texture and flavour scores were also decreased to 6.9 and 7.0 from 7.8 and 8.0 after 3 months of storage. Overall acceptability of snacks ranged from 7.00 (3 month) to 7.66. (First month) during 3 months of storage and was not much affected by 3 months of storage. Lasekan *et al.*, (1996) observed that storage at high temperature (40 °C) significantly reduced the sensory acceptance of the maize-based snacks.

### Economic evaluation

Extruded snacks are commonly consumed by the people in India. Maize-chickpea flour

blend (80:20) passed through extruder to prepare extruded snacks. Product is cheap source of balanced food. Cost includes raw material, processing and packaging expenditures (Table 5).

Maize and chickpea were blended in the ratio of 100:0, 95:5, 90:10, 85:15, 80:20, 75:25, 70:30, 65:35, 60:40 and subjected to extrusion cooking at 16 per cent moisture, 500 rpm screw speed and 150 °C temperature. The samples were subjected to sensory evaluation. The extruded snacks were evaluated organoleptically and best combination (80:20) was used for further study. It may be concluded that the incorporation of chickpea at 20% level for the preparation of extruded snack food showed an acceptable sensory scores. Storage slightly affected the overall acceptability of snacks. During the entire 3 months of storage, overall acceptability of snacks was within acceptable range. During the first month of storage snacks had moisture content and free fatty acid content values were 5.88 and 0.242, which increased to 7.18 and 0.603 respectively, whereas the hardness and overall acceptability of snacks, decreased from 90.7 and 7.66 to 79.7 and 7.00 respectively at the end of 3 months storage.

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