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Determination of Physical Characteristics of Extruded Snack Food Prepared Using Little Millet (*Panicum sumatranc)* Based Composite Flours

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Abstract- Little millet (Panicum sumatrance) has got high nutritional contents and is cultivated in rural India. Preparation of ready-to-eat snack products using extrusion cooking is a common practice. To add value to this millet in order to enable its commercialisation, ready-to-eat snack products were prepared. Composite flours were prepared using whole Little millet flour and other flours namely; sorghum, foxtail millet, black gram, and chick peas flours. Pre-conditioning was done to prepare the flours for extrusion cooking. Extrusion cooking was carried out using a twin screw extruder at optimised extrusion parameters viz., temperature: 105°C and 60°C for two different heating zones, die diameter: 3 mm, screw speed: 370 rpm and cutter speed: 22 rpm. Physical properties of the extrudate viz., bulk density, piece density, expansion ratio and moisture retention were also analysed. The organoleptic qualities of extruded samples were analysed by panellists on a 9 point hedonic scale. The results indicated that composite flour (Little millet, sorghum, foxtail millet, black gram, and chick peas flours in the ratios of 40:20:20:10:10) could be used to produce quality extrudates with acceptable sensory properties.

Keywords- Little millet Composite Flour, Pre-conditioning, Extrusion Cooking.

I. INTRODUCTION

Extrusion cooking with composite flour is a novel technique to prepare nutritional enriched food products. Extrusion cooking process is a high temperature short time process in which moist, soft grain is fed into the extruder where the desired temperature and pressure are obtained over the required period of residence time. For cooking of the product generally external heat is not supplied, heat for cooking is achieved through shear and friction in the extruder. Extrusion cooking is used worldwide for the production of expanded snack foods, modified starches readyto- eat cereals, baby foods, pasta and pet foods. (Toft, 1979). This technology has many distinct advantages like versatility, low cost, better product quality and no process effluents (Abbott 1987; Camire *et al.*, 1990). Snacks contribute an important part of daily nutrient and calorie intake for many consumers. Cereals have been popular raw materials for extrusion for food uses mainly because of functional properties, low cost and ready availability. Owing to high protein content, pulses and oil seeds can be effectively utilized for nutritional improvement of cereal based extruded snack foods. Little millet (*Panicum sumatrance*) moisture ranged 5.77-11.38 per cent and the

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protein(g) content ranged from 9.80 to 12.49. The amount of fat, ash, crude fiber and carbohydrates were in the range of 2.87-5.09, 0.98-4.78, 0.49-8.72 and 62.25-76.59g/100g respectively. Further the energy ranged between 332.26 to 382.41Kcal. Micronutrients (mg/100g) present were calcium (18-24), phosphorous (215-232), iron (3.0-10.5), potassium (125-131), sodium (6.3-7.8); zinc (2.63-4.20), copper (0.6-1.0) and silicon (0.07-1.97). Further, the total dietary fiber ranged from 9.22 to17.46 out of which, neutral detergent fiber (35.50-46.12), acid detergent fiber (13.95-16.43g/100g. Foxtail millet (*Setaria italica*) ranks second in the total world production of millets. Millet contains 9–14% protein, 70–80% carbohydrates and is a rich source of dietary fibre (Hadimani and Malleshi, 1993). It contains maximum amount of chromium among all the millets with an account of 0.030 mg per 100 g. Polymers of hexose's, pentoses, cellulose and pectinacious material constitute the major portion of its dietary fibre (Malleshi, 1986). Millet is a starchy food with a 25:75 amylose to amylopectin ratio and is a fairly good source of lipids (3–6%), having about 50% of the lipids in the form of polyunsaturated fatty acids (Sridhar and Lakshminarayana, 1994). Although millet is known to contain amylase inhibitors, the carbohydrate digestibility of millet foods is not affected because of heat-labile nature of the inhibitors (Chandrasekher *et al.*, 1981). Even though the nutritional qualities of millet have been well recorded (Hulse *et al.*, 1980), its utilization for food is confined to the traditional consumers in tribal populations, mainly due to non-availability of consumer friendly, ready-to-use or ready-to-eat products as are found for rice and wheat. In recent years, millets have received attention, mainly because of their high fibre content and efforts are under way to provide it to consumers in convenient forms.

II. MATERIALS AND METHODS

Little millet, sorghum, foxtail millet, black gram, and chick peas were ground separately and passed through a 2.5 mm screen.

A. Composite flour preparation

Blends were prepared by mixing little millet, sorghum, foxtail millet, black gram, and chick peas in the different ratios on a dry-to-dry weight basis. These blends were chosen according to preliminary tests without jamming of extruder and for acceptable product's physical characteristics as well as better nutritive value in the final product. The chosen blend was little millet, sorghum, foxtail millet, black gram, and chick peas in the ratios of 40:20:20:10:10. The blended samples were conditioned to 20–21% (w.b) moisture by spraying with a calculated amount of water and mixing continuously. Moisture content of samples was determined by hot air oven method AOAC 1990).

Table 1 Standardization of formulation of composite flours

S.No.	Flours	Proportion of Composite Flour Samples (%)		
		A	B	C
1	Little millet	50	40	30
2	Sorghum	10	20	25
3	Foxtail millet	10	20	25
4	Black gram	15	10	10
5	Chick peas	15	10	10

B. Extrusion Cooking

Feeding of the pre conditioned composite flour to a twin screw extruder was accomplished by using a twin screw volumetric gravity feeder. Based on the most stable product expansion and stability of the extruder conditions, the extrusion conditions were used (Deshpande et al., 2011). The temperature of the two barrel zones of extruder from feeder end were set at 60^{o}C and 105^{o}C respectively. Samples were collected at the most stable die temperature which was around 85^{o}C. Screw speed was set up at 370 rpm and equipped with 3-mm restriction die to extruder. Constant feeding rate was kept throughout the experiments. Three replicate samples were extruded and dried to about 5% moisture level. The dried samples were mixed with spices and edible oil.

C. Product analysis

Mass Flow Rate (MFR)

Mass flow rate was measured by collecting the extrudates in polyethylene bags for a specific period of time, as soon as it comes out of the die its weight taken instantly after its cooling to ambient temperature (Singh *et al.*, 1996).

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$$\text{MFR (gm/sec)} = \frac{\text{Weight of sample collected (g)}}{\text{Time taken to collect sample (sec)}}$$

Density of Extrudates

This indicates the overall expansion and the changes in cell structure, pores and voids developed in the extrudates as effect of processing as well as raw material parameters.

Tap Density (T.D.)

The Extrudates after grinding was filled in measuring cylinder of capacity 50 ml up to 20 ml and tapped 5-10 times. Weight of this 20ml of extrudates sample was taken.

$$\text{Tap Density (gm/cc)} = \frac{\text{Weight of 20 ml sample}}{\text{Volume of the sample (20 ml)}}$$

True Density

True Density was calculated by filling the approximate 1gm of ground sample of extrudates in a burette containing toluene. Then raised in toluene level was measured and an average of two readings of true density was calculated as

$$\text{True Density} = \frac{\text{Weight of ground sample of extrudates}}{\text{Rise in toluene level}}$$

Bulk Density

As an average diameter and average length of 25 readings of extrudates sample were known, its volume as computed as

$$\text{Vol. (cm}^3) = \pi d^2 L/4$$

Where d = Average diameter of extrudates, cm

L= average specific length of extrudates, cm

After calculating the volume of extrudates its bulk density is obtained as

$$\text{B.D. (Kg/cm}^3) = \frac{\text{Mass of extrudates (kg)}}{\text{Volume of extrudates (cm3)}}$$

Moisture Retention

The moisture content (w.b) of the feed and extruded samples was determined by AOAC method 925.10 (AOAC, 2005). Moisture retention (%) was calculated as

$$\text{Moisture Retention (\%)} = \frac{\text{Product Moisture} \times 100}{\text{Feed Moisture}}$$

Expansion Ratio

The ratio of diameter of extrudate and the diameter of die was used to express the expansion of extrudate (Fan *et al.*, 1996). The diameter of extrudate was determined as the mean of 10 random measurements made with a Vernier caliper. The extrudate expansion ratio was calculated as

$$\text{Expansion ratio} = \frac{\text{Extrudate Diameter}}{\text{Die Diameter}}$$

III. RESULTS AND DISCUSSION

Mass flow rate

Mass flow rate was minimum for extruded sample-A (3.72±0.08) followed by sample-C (3.76±0.03) and sample –B (3.84±0.02). The variations in the mass flow rate of extrudate samples were very less, due to constant maintenance of barrel temperature as well as moisture content in the feed mixtures.

Water holding capacity

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Approximately 5 grams of fine ground sample was weighed and allowed to rehydration over night in excess water after draining, it was reweighed and WHC calculated. The water holding capacity was maximum for extruded sample-B (320±0.01) than sample –C (319±0.02) and sample-A (302±0.07). But the variation between sample B and C was very less.This could be due to higher level of cereal starch and crude fibre in the composite flour sample-A. Similar results were observed by Shirani and Ganeshranee (2009) and Deshpande and Poshadri (2011). The highest moisture retention was found in the extruded product prepared using composite flour sample –C (29.3±0.02) which may be due to the increase in protein content in the composite flour sample.

Tap density

It decreased with optimum level of pulses in the composite flour. Tap density was less for sample-A (0.61±0.02) than sample –C (0.64±0.01) and sample-A (0.66±0.02).

True density

The true density was less in case of extrudates produced from composite flour sample-B (0.6±0.02) followed by sample –C (0.7±0.05) and sample –A (0.8±0.09). The true density increased with cereals starch in extrudates. Similar findings were quoted by Quing *et al*., (2005).

Bulk density

The bulk density of extrudates samples A and C were almost same but in case of sample- B (0.09±0.06), the higher bulk density may be due to the presence of more crude fibre in the composite flour sample. Similar types of results were observed by Singh *et al*. (1996).

Water Solubility Index

It was more for the extrudates made from composite flour sample –C (0.39±0.04) followed by extruded sample –B (0.37±0.07) and WSI was less for the extrudates prepared from composite flour sample-A (0.29±0.02). The water solubility index of the extrudates increased when bengal gram flour incorporation increased in the composite flour samples. The water absorption index of the extrudates increased with increase of chick pea and black gram flours in the composite flour. The water absorption index was found to be more for extruded sample –C (5.4±0.06) followed by extruded sample –B (5.2±0.07) and sample –A (5.3±0.04). These results are in conformity with the observations made by Shirani and Ganeshranee (2009).

Expansion Ratio

The result of expansion ratio of extrudates indicates that expansion ratio decreased with increased level of cereals starch and decreased amount of proteins in the composite flour –A (4.23±0.01). This decrease in expansion ratio could be because of high level of little millet flour, which is rich in dietary fibre. Protein affects expansion through their ability to effect water distribution in the matrix and through their macro molecular structure and confirmation. The extruded sample –B (4.46±0.05) has more expansion ratio than extruded sample –C (4.34±0.03) and extruded sample-A. Similar findings were reported by Singh *et al.* (1996).

Oil absorption

Oil absorption was found to be more for extruded sample-A (7.10±0.02) than sample-B (6.4±0.03) and C (5.9±0.07). However, the higher absorption of oil may be attributed to presence of less fat and more crude fibre in case of extrudate sample prepared from composite flour-A.

Sensory attributes

The sensory assessments were conducted with a panel of 25 members consisted of staff and post graduate students of the College of Food and Dairy Technology, TANUVAS, Chennai. The panels members were given the extruded snack food samples for evaluation of organoleptic characteristics viz. appearance, colour, taste, flavour, texture and overall acceptability. It was served to judges on the day of preparation. The average score recorded by judges was considered. The mean scores of sensory evaluation showed that all the extruded products prepared from composite flours were within the acceptable range, while the extruded product prepared from composite flour sample-B had significantly better appearance (7.6±0.01), color (7.7±0.04), flavour (8.0±0.02), texture (8.9±0.05), taste (8.5±0.05) and overall acceptability (8.8±0.04) when all the prepared extruded samples were compared with the commercial control.

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Table 2 Physical properties of extrudates

Properties	Samples		
	A	B	C
Mass flow rate (g/s)	3.72±0.08	3.84±0.02	3.76±0.03
Tap density (g/cc)	0.61±0.02	0.66±0.02	0.64±0.01
True density (Kg/cm^3)	0.8±0.09	0.6±0.02	0.7±0.05
Bulk density (Kg/cm^3)	0.10±0.03	0.09±0.06	0.10±0.09
Water Solubility Index (%)	0.29±0.02	0.39±0.04	0.37±0.07
Water Holding Capacity (WHC)	302±0.01	320±0.02	319±0.07
Moisture Retention	29.3±0.02	25.71±0.06	25.82±0.02
Expansion Ratio	4.23±0.01	4.46±0.05	4.34±0.03
Water Absorption Index (%)	5.3±0.04	5.2±0.07	5.4±0.06
Oil Absorption Capacity (%)	7.10±0.02	6.40±0.03	5.90±0.07

IV. CONCLUSION

The composite flour consisting little millet, sorghum, foxtail millet, black gram, and chick peas flours in the ratios of 40:20:20:10:10 could be used to produce good quality extrudates with acceptable sensory characteristics.

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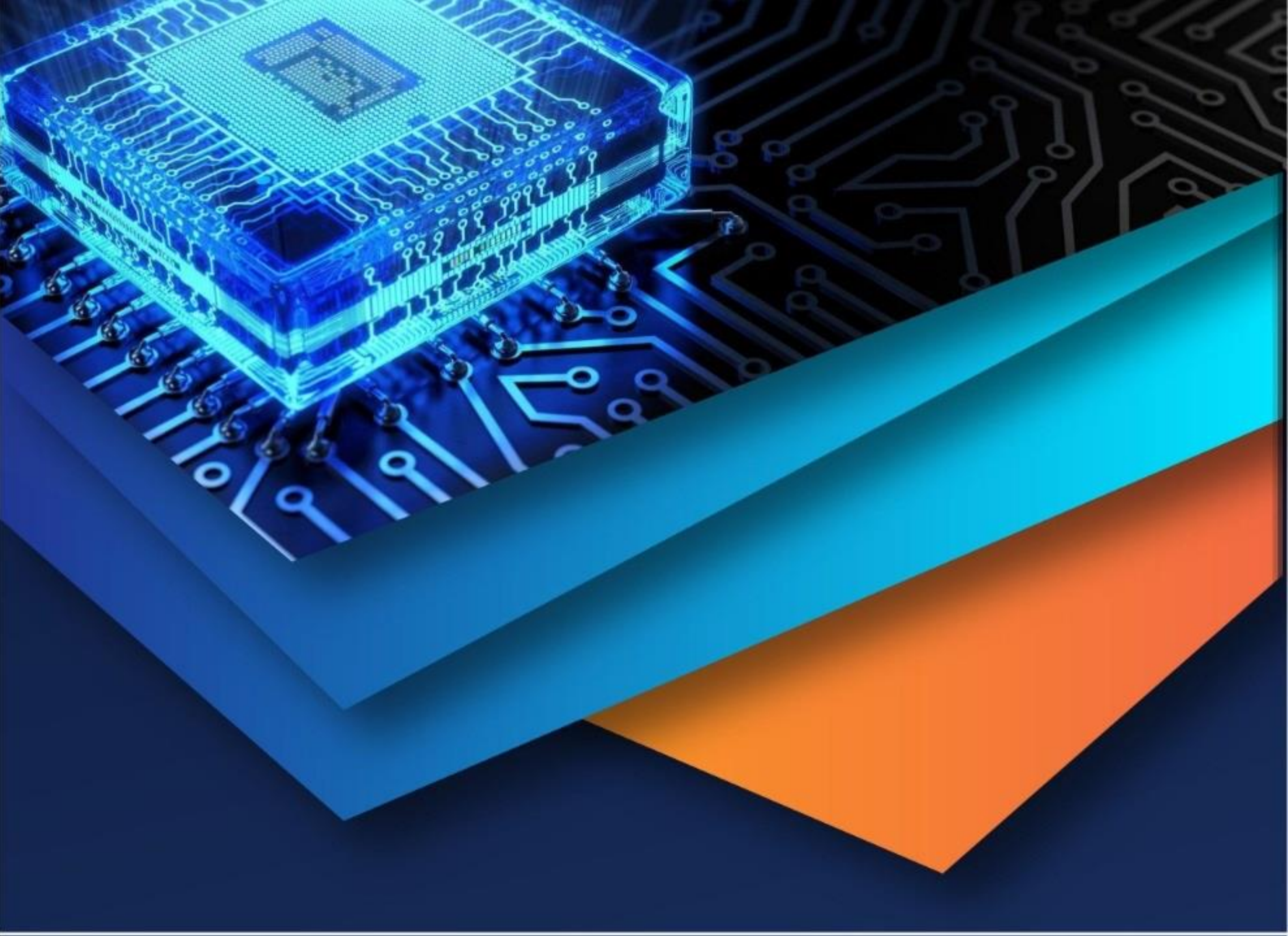

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