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Standardization and Nutrient Composition of the Proso Millet *Chakli*

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ABSTRACT: Proso millet *(Panicum miliaceum*) is common and important minor millet belonging to the family Gramineae. This short duration millet variety is widely grown in India. Proso millet has high nutritive value which is rich in protein (13.96 g) and minerals (2.60) and is comparable to major cereal grains. Realizing the awareness of the consumers towards the nutritional and health benefits, proso millet was incorporated in preparation of *chakli*. In this study proso millet c*hakli* was standardized with 65 per cent of proso millet flour, rice flour and other spices. The standerdised *chakli* can be stored up to one month in aluminium pouches without any quality deterioration. The results illustrate that 100 g *chakli* contains 50.26 per cent carbohydrates, 9.51 per cent protein, 30.47 per cent fat, 2.48 per cent ash, 7.28 per cent moisture, 2.37 per cent crude fiber, 40.10 mg/kg of iron, 20.10 mg/kg of zinc and 260.30 mg/kg of calcium.

Key words: Proso millet, standardization, organoleptic evaluation, shelf life and *chakli.*

INTRODUCTION

Millets are one of the most ancient crops, which were domesticated about 10000 years ago (Houyuan *et al.,* 2009). According to some stone-age fossils, millets were considered as important grains in the area of Hungary. With the development of milling technologies, other cereals replaced millets and today this cereal has become negligible (Berei *et al*., 1962). In the semi-arid zones of Africa and in the lower socio economics trata of the Indian subcontinent, common grains like wheat, corn or rice cannot be cultivated because of the poor environmental and agricultural circumstances. Millets areone of the most consumed staple foods and are the major sources of energy and protein for millions of people in these areas. About 80% of the world's millet production is used in human nutrition (ICRISAT/FAO, 1996; Obilana & Manyasa, 2002; Obilana, 2003).

Proso millet is popularly known as Broomcorn millet (China), Common millet (USA), Barri (India), Broomtail millet, Kashfi Millet, Red Millet, and White Millet, Brown Millet, Chinese Millet, Kibi, Mijo (Spain), Panic Millet (France), Gijang (Korea) in different climatic zones (Lyon *et al.*, 2008); (Habiyaremye *et al.*, 2017). It is widely cultivated in India, China, Nepal, Africa, Russia, Ukraine, Belarus, Middle East, Turkey and Romania. It is one of the best-suited crops for the rain fed agricultural system where annual rainfall is $\leq$100 mm (Santra, 2013).

Nutritional quality is the key element that determines the dietary importance of a grain and its importance towards human health. Proso millet is known for several health benefits. It is highly nutritious and is comparable to major cereal grains. The DhPM-2769 variety proso millet is composed of 77.33 g of carbohydrates, 13.96 g of protein, 3.35g of fat, 2.6 g of minerals and 2.66 g of crude fiber per 100 g which is comparable to other millets. Also it contains micro nutrients such as iron (3.78 mg), manganese (8.82 mg), zinc (13.33 mg) and copper (5.90 mg) per 100 g sample (Sarojani *et al*., 2021). Proso millet has all the essential amino acids viz. methionine (160 mg/100g), phenylalanine (307 mg/100g), tryptophan (49 mg/100g), valine (407 mg/100g) (http://www.fao.org/docrep/t0818e/T0818E0d.htm). Major nutritional component protein, carbohydrate, and energy values are comparable to popular cereals like rice, wheat and barley. Proso millet of DHPM-2769 variety contains higher protein13.96% (Sarojani *et al*., 2021) which is comparable to wheat (14.4%) and higher than rice (7.5%) (Devi *et al.,* 2014).

Moreover, proso millet has low glycemic index (GI) compared to rice, wheat, and barley, which makes it an ideal food for people with type-2-Diabetes Mellitus and cardiovascular disease (CVD). Products prepared with 100% proso millet showed GI (%/g) of 50–65 compared to 70–80 of refined corn and wheat-based products (Park *et al.,* 2008). Proso millet protein has an important role in cholesterol metabolism as they can increase concentration of the high-density lipoprotein (HDL) cholesterol level, especiallythe isomer HDL2, and adiponectin without affecting the concentration of low-density lipoprotein (LDL) cholesterol (Turer and Scherer 2012). Proso millet contains a high amount of lecithin which plays an importantrole in the neural health system by repairing and regenerating myelin fiber and intensifying braincell metabolism. Proso millet also contains significantly high amount of B- complex vitamin like folic acid and niacin (Fasano, 2003). Proso millet is also valuable in prevention of CVD and cancer (Zhang *et al.,* 2014).

Among the convenience foods, a major share of market belongs to the category of deep fried snacks. The origin of most of these products can be traced to the traditional practices of better preservation techniques for which, fried foods have naturally became a choice due to their shelf stability (Kumari and Prakash, 2009). Snacks contribute to higher percentage of daily nutrient and calorie intake in many consumers (Chakraborty *et al.*, 2011). *Chakli* is a common term for a variety of fried snacks that can be made using different combination of in gredients. *Chakli* are delicious savories that are generally made at home and kept in airtight containers for eating and fancied as enjoyable, crunchy and satisfactory snack. Though Proso millet is rich in good quality proteins, minerals, crude fibre the availability of the products in market, prepared from this millet are scanty. Hence, there is need to develop products from proso millet and popularize among consumers and create market network. In view of increasing number of working women, there is demand for ready to eat nutritious snacks. Hence, an attempt was made to standardise proso millet *chakli* and study shelf life.

MATERIALS AND METHODS

Raw materials: Zero polished proso millet was procured from the Green Organics, Dharwad. Other ingredients and spices were purchased from the local market of Dharwad, Karnataka.

Procedure for the preparation of *Chakli* is shown in Fig. 1,

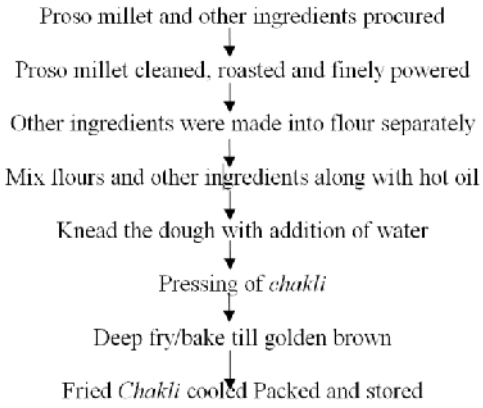

Fig. 1. Method for the preparation of Proso millet *chakli.*

Standardization of the proso millet *chakli:* Proso millet *chakli* was standardised by varying proso millet flour and using other ingredients like pulses and spices. The spices to be added like cumin, sesamum, asafetida, ajwain and chilli powder were standardised.

Sensory evaluation of the developed products: Semi - trained panelists (10) evaluated proso millet *chakli* samples for sensory parameters using 9 point hedonic scale, where 1- dislike extremely, 2- dislike very much, 3- dislike moderately, 4- dislike slightly, 5- neither like nor dislike, 6- like slightly, 7- like moderately, 8- like very much and 9- like extremely by a semi trained panel of ten judges for the appearance, texture, flavor, taste and overall acceptability. Acceptability index was calculated by summing up of all the sensory scores of appearance, texture, flavor, taste and overall acceptability and it was divided by maximum score (54) and multiplied by 100 (Bustos *et al.*, 2011).

$$\text{Acceptability Index(AI)} = \frac{\text{Total scores} \times 100}{\text{Maximum score}} \quad (1)$$

Storage stability of proso millet *chakli:* Storage stability of developed proso millet *chakli* was studied at ambient conditions by storing them in Aluminium foil pouches (150 g per pack). The packed samples were stored at ambient conditions of Dharwad (Karnataka state) for three months. The stored pasta was periodically analyzed at 15 days intervals and evaluated for changes in moisture, free fatty acid and sensory qualities.

Moisture content: A known quantity of sample was weighed into previously weighed moisture cups and dried in a hot air oven at 98 to 100º C to a constant weight (AOAC 2005). Moisture content was calculated using the formula

$$\text{Moisture content (\%)} = \frac{\text{Intitial weight} - \text{Final weight}}{\text{Weight of the sample}} \times 100 \quad (2)$$

Free fatty acid content (% acid value): The amount of free fatty acid content present in the proso millet *chakli* indicates the quality of fat in foods. Standard procedure was used to estimate the free fatty acid content of proso millet *chakli.*

Reagents used are 1% phenolphthalein in 95% ethanol, 0.1 N potassium hydroxide and Neutral solvent: Mix 25 ml diethyl ether, 25 ml 95% alcohol and 1 ml of 1% phenolphthalein solution and neutralize with N/10 alkali.

Procedure: 50g of sample was added in 1:1 chloroform and methanol mix (150ml: 150ml). The mixture kept overnight and extract was filtered. In a conical flask 25 ml of filtrate was added with 50 ml of hot neutral alcohol and 3-4 drops of phenolphthalein indicator. Titrate the contents against 0.1 N potassium hydroxide. Shake constantly until a pink colour which persists for fifteen seconds is obtained.

$$\text{Acid value (mg KOH/g)} = \frac{\text{Titre value} \times \text{Normality of KOH} \times 56.1}{\text{Weight of the sample (g)}} \quad (3)$$

Nutrient Composition of the Proso millet *Chakli:* The selected composition of proso millet *chakli* was analysed for nutrient content in the NABL accredited laboratory at PJTSAU, Hyderabad for nutrition labeling.

Statistical analysis: SPSS statistical software (version 16, SPSS Inc) was used to perform the statistical analysis of the data. Analysis Of Variance (ANOVA) followed by Duncan's multiple range test was performed to determine significant differences. For comparison of two treatment means, t-test was used.

RESULTS AND DISCUSSION

Formulation of Trial 1:

Trial 1 was carried out with increase in proportion of proso millet flour along with other ingredients.

Cooking characteristics of proso millet *chakli* in Trial 1: Cooking characteristics of the proso millet *chakli* showed that (Table 1) water required for dough preparation increased with the increase in proso millet flour in *chakli* flour mix, ranging from 70 to 90 ml, with the highest being in 90 per cent incorporation of proso millet flour. The oil absorption during frying also increased with increase in proso millet flour in *chakli* and itranged from 75 to 90ml, highest being in 80 and 90 per cent of proso millet *chakli.* However, in a study conducted by Leena *et al.,* (2005) it was stated that the control *chakli* contained 19.2 per cent fat. Further on incorporation of 5per cent of finger millet, there was adefinite increase in oil content of about 24 per cent. On increasing the incorporation of finger millet to 15 per cent, a decrease was observed, ranging from 21.1 per cent in *chakli* made with untreated finger millet to 19.1 per cent in the dry heat treated product and to 18.8per cent in the gelatinized finger millet product.

In the present study, it was observed that as the proportion of millet increased, frying time for *chakli* also increased. The time for frying proso millet *chakli* ranged from 4-7 minutes with longest in 90 per cent proso millet flour incorporation. The yield of *chakli* was from 110 to 120 g by using 100 g flour.

Table 1: Cooking characteristics of Proso millet *chakli* Trial 1.

Proso millet flour (%)	Water for dough preparation (ml)	Oil absorption (ml)	Frying time (minute)	Final yield (g)
90	90	80	7	115
80	80	80	6	110
70	70	75	4	120

Organoleptic evaluation of Trial 1: The Overall acceptability scores for 70 per cent (7.40) proso millet flour incorporated *chakli* was higher compared to 80 per cent (6.80) and 90 per cent (6.50) proso millet flour incorporation (Table 2). Proso millet *chakli* with 70 per cent proso millet flour had the highest scores for appearance (8.10), colour (8.10), flavour (7.50), taste (7.00), texture (7.40), and overall acceptability (7.40). The scores for colour and texture were significantly higher in 70 per cent proso millet flour incorporated *chakli* compared to 80 and 90 per cent incorporation. The scores for taste and texture in 90 per cent and 80 per cent proso millet incorporation were less than 7.00 and were bitter in taste. Hence, this proportion was not considered for further trials. It was observed that 70 per cent incorporation of pros millet had the better shape and texture but the *chakli* tasted slightly bitter. However, Leena *et al.,* (2005) reported that incorporation of gelatinized finger millet flour (5%) scored significantly higher for texture, flavor and overall acceptability in comparison with the control.

Table 2: Mean organoleptic scores of Proso millet *chakli* prepared from Trial 1.

Proso millet (%)	Appearance	Colour	Flavour	Taste	Texture	Overall acceptability
90	7.00 ± 1.41	7.20^{b} ± 0.92	7.33 ± 0.71	6.80 ± 0.79	6.00^{b} ± 1.05	6.50 ± 0.53
80	7.40 ± 0.84	7.20^{b} ± 0.79	6.80 ± 1.14	6.60 ± 1.26	6.00^{b} ± 1.33	6.80 ± 1.32
70	8.10 ± 0.74	8.10^{a} ± 0.74	7.50 ± 0.53	7.00 ± 1.05	7.40^{a} ± 0.97	7.40 ± 0.70
F value	2.86	4.03	1.91	0.36	5.13	2.52
SEm	0.33	0.26	0.26	0.33	0.36	0.29
CD	NS	0.75*	NS	NS	1.04*	NS

*Significant at 5% level ($p<0.05$), NS: Non-significant, No. of replications: 10

Values in a column followed by different Superscripts are significantly different according to DMRT at the 0.05 level.

The acceptability index is highest in 70 per cent proso millet flour incorporated *chakli* (84.26) compared to 90 per cent (75.62) and 80 per cent (75.56) incorporation (Fig. 2).

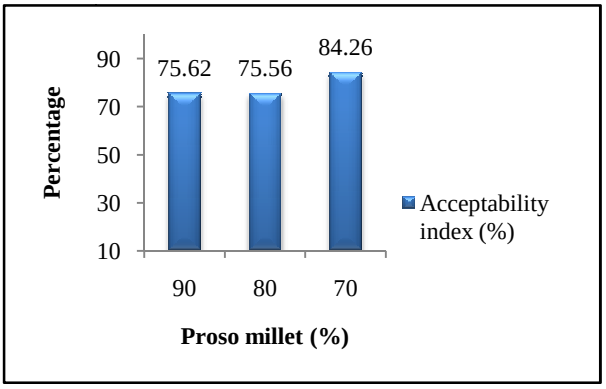

Fig. 2. Acceptability index of Proso millet *chakli* prepared from Trial 1.

Formulation of Trial 2:
To reduce the slight bitterness observed in 70 per cent proso millet incorporated *chalk* it was suggested to vary the spice mix. Hence Trial 2 was conducted by varying spices with 70 per cent and 75 per cent proso millet flour.
Cooking characteristics of proso millet *chakli* in Trial 2: In Trial 2 cooking characteristics were not varied. In both the variations 70 ml water was added for the dough preparation and oil absorption was same (75 ml). Frying time taken was 3 minutes. The weight of final yield ranged from 125 to 130 g from 100 g flour mix.

Table 3: Cooking characteristics of Proso millet *chakli* Trial 2.

Proso millet flour (%)	Water for dough preparation (ml)	Oil absorption (ml)	Frying time (minute)	Final yield (g)
70	70	75	3	125
75	70	75	3	130

Organoleptic evaluation of Trial 2: Table 4 revealed that the overall acceptability scores for 75 per cent (7.90) proso millet flour incorporated *chakli* was higher compared to 70 per cent (7.70) proso millet flour incorporation. The most acceptable proso millet *chakli* with 75 per cent incorporation of proso millethad higher scores for appearance (8.20), colour (8.20), flavour (7.70), texture (8.10), and overall acceptability (7.90). The score for texture was significantly higher in 75 per cent proso millet flour incorporated *chakli* compared to 70 per cent incorporation. Both the variations had the good shape and texture but the *chakli* tasted slightly bitter and hard.

Table 4: Mean organoleptic scores of Proso millet *chakli* Trial 2

Proso millet (%)	Appearance	Colour	Flavour	Taste	Texture	Overall acceptability
70	8.10±0.74	8.00±0.82	7.50±0.85	7.70±0.82	7.30±0.95	7.70±0.67
75	8.20±0.79	8.20±0.79	7.70±0.82	7.60±0.97	8.10±0.74	7.90±0.74
F value	0.086	0.31	0.286	0.062	4.431	0.4
SEm	0.24	0.25	0.26	0.28	0.27	0.22
CD	NS	NS	NS	NS	0.80*	NS

*Significant at 5% level (p<0.05), NS: Non-significant, No. of replications: 10

The acceptability index is highest in 75 per cent proso millet flour incorporated *chakli* (88.33) compared to 70 per cent (85.74) proso millet flour incorporated *chakli* (Fig. 3).

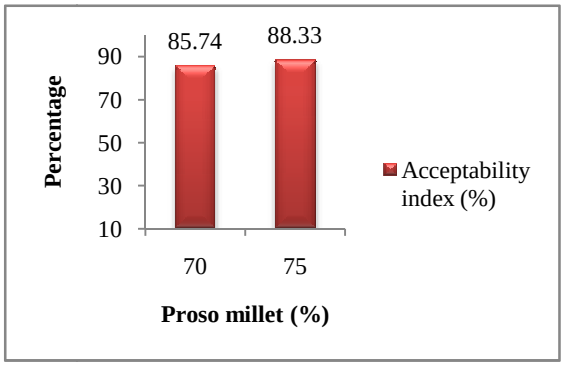

Fig. 3. Acceptability index of Proso millet *chakli* prepared from Trial 2.

Formulation of Trial 3:
In Trial 3, to reduce the bitterness and to improve the texture it was suggested to add rice flour with 65 per cent proso millet flour and then it was compared with 75 per cent proso millet. Other ingredients were kept same as Trial 2.
Cooking characteristics of proso millet *chakli* in Trial 3
In Table 5cooking characteristics were not varied. In both the variations, 70 ml water added for the dough preparation and oil absorption was same (65 ml). Frying time taken was 3 minutes. From the 100 g flour mix the weight of final yield was 135 g.

Table 5: Cooking characteristics of Proso millet *chakli* Trial 3.

Proso millet flour (%)	Water for dough preparation (ml)	Oil absorption (ml)	Frying time (minute)	Final yield (g)
75	70	65	3	135
65& rice flour	70	65	3	135

Organoleptic evaluation of Trial 3: According to Table 6, overall acceptability scores for 65 per cent (7.70) proso millet flour incorporated *chakli* was higher compared to 75 per cent (7.60) proso millet flour incorporation. The most acceptable proso millet *chakli* with 65 per cent proso millet flour had the sensory scores for appearance (8.30), colour (8.30), taste (8.00), texture (7.90) and overall acceptability (7.70). As there was no significant difference between the two variations looking into the acceptability index and crispy texture the variation with 65 per cent proso millet flour and other ingredients was finalized as the standard recipe. In a study conducted by Bond, (2004) the use of rice as a major ingredient may be attributed to the crispiness,

characteristic, which gives a better texture since the viscosity was not as high as in the rice when liquid was added like other types of grain flours and formed a batter with high degree of solids which acted as buffer in the cooking process to absorb liquids and thus the rice flour batter would have produced a dry texture. In a study by Namita *et al.,* (2009) stated that *chakli* prepared with 100 per cent foxtail millet flour scored more for colour, appearance, flavor, taste, texture and overall acceptability when compared to control, 25, 50, 75 per cent incorporated *chakli*. In a study conducted by Singson *et al.,* (2014) most of the chakli samples procured from the shops of different areas either branded or unbranded showed that majority were prepared using rice (86 %) as the basic ingredient and millets were used only up-to 6 per cent.

Table 6: Mean organoleptic scores of Proso millet *chakli* Trial 3.

Proso millet (%)	Appearance	Colour	Flavour	Taste	Texture	Overall acceptability
75	7.80±0.63	7.60±0.52	7.70±0.48	7.70±0.48	7.70±0.48	7.60±0.52
65& rice flour	8.30±0.67	8.30±0.67	7.70±0.82	8.00±0.94	7.90±0.74	7.70±0.67
F value	2.92	6.79	0.00	0.80	0.51	0.14
SEm	0.21	0.19	0.21	0.24	0.20	0.19
CD	NS	NS	NS	NS	NS	NS

*Significant at 5% level ($p<0.05$), NS: Non-significant; No. of replications: 10

The acceptability index is highest in 65 per cent proso millet flour incorporated *chakli* (88.70) compared to 75 per cent (85.37) proso millet flour incorporated *chakli* (Fig. 4).

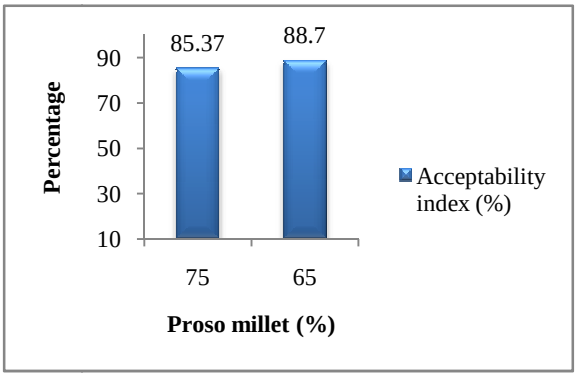

Fig. 4. Acceptability index of Proso millet *chakli* prepared from Trial 3.

Effect of storage on moisture content and free fatty acid content of Proso millet *chakli:* The changes in the moisture content of the proso millet *chakli* during storage were shown in table 7. The initial moisture content was 2.16 per cent. It was increased significantly to 4.12 per cent on 60th day of storage. According to Gautam and Gupta (2017) the increase in moisture content of all prepared food products *namkeen sev, chakli, seviyan and* kachri was slow during storage. This is may be due to that kachri is a dehydrated preserved extruded food product so the moisture content was very low.

Free fatty acid content was 0.10 mg KOH/g on initial day. The value increased significantly to 0.40 mg KOH/g on 60th day. There was sudden increase in free fatty acid content on 60th day. Rancidity was developed. Hence, the study was discontinued. Similar study was done by Gautam and Gupta (2017) in case of pearl millet *chakli* the free fatty acid was slight increased from 0 days to 90 days. The mean values of free fatty acid of all treatment were increased slightly.

Proso millet *chakli* developed under this study was found very low free fatty acid content, so the proso millet chakli can be successfully consumed at least for one month. Thus, this snack food could be of great help in improving the health snack food peoples by serving as good supplements and provide a new way of consumption.

Table 7: Moisture and free fatty acid content during storage of proso millet *chakli.*

Days	Moisture (%)	Free fatty acid content (mg KOH/g)
Initial day	2.16±0.07	0.10
15	2.35±0.07	0.12
30	2.93±0.06	0.14
45	3.66±0.06	0.15
60	4.12±0.17	0.40
F	234.30	1867.83
SEm±	0.05	0.02
CD	0.17**	0.06**

*significant at 5 % level, ** significant at 1% level, NS- Non significant, No. of replications: 3

Effect of storage on organoleptic quality of Proso millet *chakli*: The sensory acceptability of the proso millet *chakli* were assessed on each withdrawal during storage period and recorded in terms of appearance, colour, flavor, texture, taste and overall acceptability and are presented in the Table 8. The initial scores for overall acceptability of proso millet *chakli* was 8.40 which was decreased significantly ($p<0.01$) to 4.30 on 45th day of storage. On 45th day due to rancidity off-flavour and off - odour was observed. Hence, the study was discontinued. In a study conducted by Namitha *et al.,* (2019) the overall acceptability scores are

indicating that there is major difference in colour and appearance, flavour, texture taste and overall acceptability value of murukku (chakli) during storage period in decreasing manner. Aluminium foil got good scores when compared to LDPE. Similar results were found in little millet *chakli* prepared by Singson *et al.*, (2014).

Table 8: Effect of storage on organoleptic quality of proso millet *chakli.*

Storage days	Appearance	Colour	Flavor	Taste	Texture	Overall acceptability	Acceptability Index
Initial day	8.50±0.71	8.50±0.71	8.40±0.70	8.30±0.95	8.50±0.53	8.40±0.70	93.70
15	8.10±0.32	8.20±0.42	7.90±0.57	7.80±0.63	7.90±0.58	7.80±0.42	88.33
30	8.20±0.63	8.10±0.57	7.90±0.57	7.80±0.63	7.90±0.74	7.70±0.48	88.15
45	6.50±0.71	7.50±0.53	4.20±1.32	3.90±0.88	6.40±1.07	4.30±0.82	60.74
F	6.17	8.17	8.08	6.27	6.08	7.42	
SEm±	0.21	0.21	0.21	0.24	0.21	0.20	
CD	0.14**	0.13**	0.13**	0.19**	0.14**	0.11**	

*significant at 5 % level, ** significant at 1% level, NS- Non significant, No. of replications: 10

Values in a column followed by different Superscripts are significantly different according to DMRT at the 0.05 level

Nutrient Composition of the Proso millet *chakli:* Nutrient composition of the proso millet *chakli* was analyzed from the PJTSAU, NABL accredited laboratory, Hyderabad for nutrition labeling. It was found that 100 g proso millet *chakli* contains 50.26 per cent carbohydrates,9.51 per cent protein, 30.47 per cent fat, 2.48 per cent ash, 7.28 per cent moisture, 2.37 per cent crude fiber (Fig. 5), 40.10 mg/kg iron, 20.10 mg/kg zinc and 260.30 mg/kg calcium. 100 g *chakli* provides 513 kcal of energy and hence it is a energy rich snack. Consuming two *chakli* of 32 g will give128 kcal. Chavan *et al.,* (2016) reported that sorghum *chakli* of seven varieties had mean 14.72% protein, 2.79%total sugars, 38.60% fat, 3.34% crude fiber and 2.71% ash. Fat percentage is slightly higher in study reported by Chavan *et al.*, (2016). However in a study conducted by Namitha *et al.*, (2019) the fat content was lesser (18.4 %) and crude protein was slightly higher (11.38 %), higher ash content (3.25%), higher crude fibre (6.00 %) which is because of the variation of the ingredients.

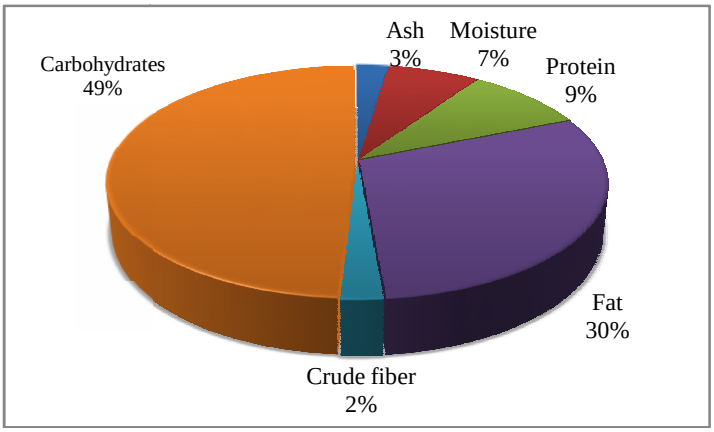

Fig. 5. Proximate composition of Proso millet *Chakli.*

Economics for the production: According to Table 9the cost of production of 5kg proso millet *chakli* is Rs. 2000/- which costs out Rs. 400 per kg.

Table 9: Cost of production of proso millet *chakli* (5 kg).

Particulars	Cost (Rs)
Ingredients cost	1420.00
Labour cost (37 Rs./hr)	300.00
Fuel cost	280.00
Total	2000.00

Proso millet

Proso millet *Chakli*

CONCLUSION

These results indicated that proso millet *chakli* prepared from 65 per cent proso millet flour with other ingredients and spices was having better organoleptic properties when compared to the other treatments. Proso millet *chakli* was crunchy and crispy in nature. It is highly nutritious snack with high protein and energy, very much suitable for children, adolescents and elders. The snack can be stored for one month at ambient temperature, packed in food grade aluminium pouches. There is still scope for research to enhance the shelf life by addition of natural anti oxidants like beta carotene and modifying packaging techniques.

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