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Development and Nutritional Evaluation of Foxtail Millet (*Setaria italica*) based *Laddu*

K.V. Sudha[1], Sarojani J. Karakannavar[1], Basavraj Inamdar[2], Nirmala B. Yenagi[1]

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ABSTRACT

Backround: Foxtail millet (*Setaria italica*) is known for its health benefits as it is nutritionally superior to conventional food grains. *Laddu* are ball-shaped sweets which are popular in India and are often served at festive or religious occasions. Hence, an attempt was made to develop foxtail millet based value added *laddu*.

Methods: *Besan laddu* was taken as control. Optimized foxtail millet *laddu* were nutritionally evaluated for proximate composition, sugars and minerals. Paired 't' test was used to compare the physical parameters and nutrient composition of *besan* and foxtail millet *laddu.*

Result: The developed foxtail millet *laddu* had the 11.61, 17.52, 2.64, 1.11 and 66.85% per 100 g of protein, fat, crude fibre, ash and carbohydrate respectively. There was no significant difference in sugar composition between the control and the optimised *laddu*. However, it was observed that the calcium, iron, zinc, copper and manganese of foxtail millet *laddu* were high as compared to control *laddu*.

Key words: Foxtail millet *laddu,* Mineral, Physical parameters, Proximate composition.

INTRODUCTION

With improvement in food technology, convenience food and ready to eat foods are emerging in market. Convenience foods have also been described as foods that have been created to "make them more appealing to the consumer." And they also save time. They are commercially prepared (often through processing) to optimize ease of consumption. Such food is usually ready to eat without further preparation. It may also be easily portable, have a long shelf life, or offer a combination of such convenient traits. Types of convenience foods can vary by country and geographic region. Convenience foods include ready-to-eat dry products, shelf-stable foods, prepared mixes and snack foods. Hence are gaining more popularity.

Traditional foods are developed through ages invented, modified, utilized and evolved to overcome the monotony in the diet. India has rich treasure of traditional foods specifically prepared for festivals, rituals and physiological conditions (Inamdar *et al.,* 2005). The traditional food of India has been widely appreciated for its fabulous use of locally grown crops. Value addition of some traditional food products with millets showed to be a highly strategic intervention in the popularization of nutritionally rich local crops *i.e*. millets. which are currently largely neglected and underutilized (Yenagi *et al*., 2010). Foxtail millet is a good source of protein (12.3 g/100 g) and dietary fibre (14 g/100 g). The carbohydrate content is low (60.9 g/100 g). Besides, it is rich in minerals (3 g/100 g) and phytochemicals (Gopalan *et al.,* 2010).

Laddu is an Indian sweet made from a mixture of flour, sugar and shortening and other ingredients that vary by recipe, which is shaped into a ball. Further, the significance of traditional foods is more appreciable when their nutritive value is known. Hence the study was taken to develop the Foxtail millet based *laddu* and it was nutritionally analysed.

[1]Department of Food Science and Nutrition, College of Community Science, University of Agricultural Sciences, Dharwad-580 005, Karnataka, India.

[2]Department of Animal Genetics and Breeding, Veterinary College, KVAFSU, Hebbal, Bengaluru-560 024, Karnataka, India.

Corresponding Author: K.V. Sudha, Department of Food Science and Nutrition, College of Community Science, University of Agricultural Sciences, Dharwad-580 005, Karnataka, India.
Email: kvsudha89@gmail.com

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MATERIALS AND METHODS

The present study was carried out in the Department of Food Science and Nutrition, UAS, Dharwad Karnataka during the year 2018-2019. The raw materials like foxtail millet, bengal gram dhal flour, ghee and sugar powder were purchased from the local market of Dharwad, Karnataka. The millet grains were washed, rinsed, shade dried and milled from the local commercial milling machine.

Development of Foxtail millet *laddu*

Standardization trials indicated that acceptable foxtail millet *laddu* (Fig 1 shows the preparation of optimised *Laddu*) could

be developed by incorporating 50 per cent foxtail millet flour, 50 per cent bengal gram dhal flour, 45 per cent ghee, 75 per cent sugar powder and 40 minutes of roasting time in the standard *laddu* recipe (Sudha, 2016). *Besan laddu* (100 per cent bengal gram dhal flour, 50 per cent ghee, 85 per cent sugar powder and 45 minutes of roasting time) was taken as control (Fig 2 shows the *besan laddu* and the developed foxtail millet *laddu*).

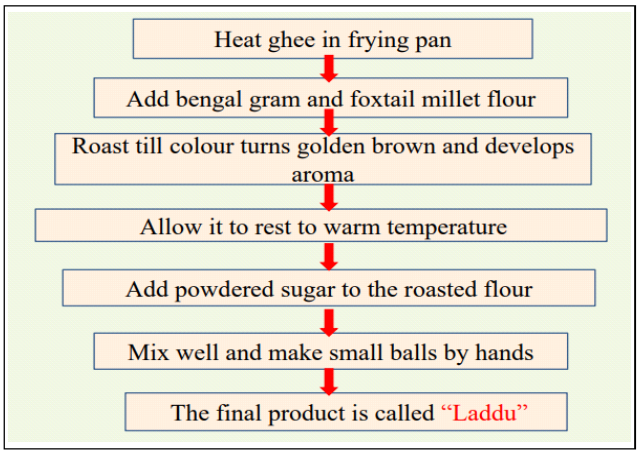

Fig 1: Flow diagram for preparation of optimized *laddu.*

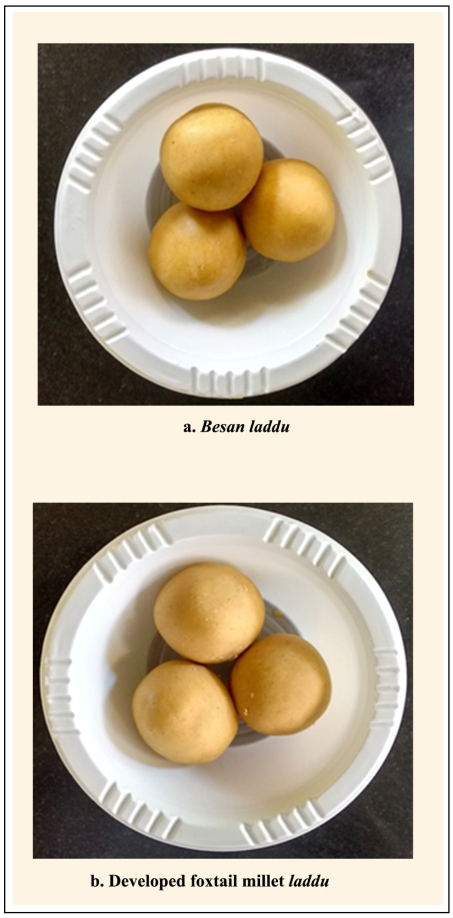

Fig 2: a *Besan Laddu* and b. Developed Foxtail millet *Laddu.*

Physical parameters

a. Colour of the *laddu*

Chromatic component, L (lightness), a (redness) and b (yellowness) values of sample were measured using spectrophotometer (Colour lab + Premier colour scan).

b. Weight of the *laddu* (g)

The weight of a *laddu* was determined by the weighing balance.

c. Volume of the *laddu* (ml)

It was determined by seed displacement method. Mustard seeds were loaded into 100 ml beaker until it is full and it was unloaded back. The *laddu was* put into the beaker and the measured mustard seeds were loaded back again in the beaker. The remaining mustard seeds left outside the beaker were measured using the measuring cylinder and volume (ml) was noted.

d. Circumference of the *laddu* (cm)

A white thread was rolled around the laddu to measure the circumference. And this threads length was measured with a measuring scale.

Nutritional analysis

The developed Foxtail millet *Laddu* were analysed for proximate composition, sugars and minerals.

a. Moisture

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

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

b. Protein:

Nitrogen content of cookies was estimated in Kelplus dx of pelican make and crude protein content was calculated by multiplying with a factor 6.25 (AOAC 2005).

$$\text{Nitrogen (\%)} = \frac{14 \times \text{Normality of the acid} \times \text{Titre value}}{\text{weight of the sample}} \times 100$$

c. Fat:

Fat content was estimated in Socs plus apparatus SCS -2 model of pelican make. The total crude fat content was calculated using the formula (AOAC 2005).

$$\text{Fat content (g/100 g)} = \frac{\text{Weight of ether extract}}{\text{Weight of the sample}} \times 100$$

d. Crude fibre

Crude fibre was estimated by the acid alkali digestion method by using fibra plus instrument (Pelican equipments). Fat free sample was hydrolysed with sulphuric acid and sodium hydroxide. The residue obtained after digestion was dried in a crucible and its weight was recorded (We).

The dried residue was then ashed in a muffle furnance at 600°C for three hours and its weight (Wa) was recorded (AOAC 2005).

$$\text{Crude fibre \%} = \frac{\text{We - Wa}}{\text{Weight of fat free sample (g)}} \times 100$$

e. Ash

Samples of 5 g was weighed in a previously weighed silica crucible and charred to remove the organic matter. The process was continued till no more smoke emitted. The crucible with charred sample was ignited to ash in a muffel furnace at 600°C for 6 hours. The crucibles was allowed to cool in desiccator and weighed (Anonymous, 1990). Total mineral (ash) content is calculated employing the formula:

Weight of ash =

Weight of crucible after igniting (g) - Weight of crucible (g)

$$\text{Ash (\%)} = \frac{\text{Weight of ash}}{\text{Weight of fat free sample}} \times 100$$

f. Total carbohydrate

The total carbohydrate content was calculated by the following formula:

Total carbohydrate =

100 - (% moisture + % fat + % protein + % ash)

Available carbohydrate =

100 - (% moisture + % fat + % protein + % ash + % crude fibre).

g. Sugar

The total and reducing sugars were determined as per the procedure of Nelson Somogyi (Sadhasivam and Manikam, 2008). Non reducing sugar was computed by subtracting reducing sugar from total sugar.

Non reducing sugar =

Total sugar - Reducing sugar × (0.95)

h. Iron, zinc, copper, manganese and calcium (mg/100 g)

Iron, zinc, copper, manganese were determined by Atomic Absorption Spectroscopy method. Calcium was determined by precipitating it as calcium oxalate and titrating the solution of oxalate in dilute H_2SO_4 against standard $KMnO_4$ (Anonymous, 1990).

Sensory evaluation

Sensory qualities of the value added foxtail millet based *laddu* was conducted in comparison with *besan laddu*. A nine point hedonic scale was used, which describes sensory attributes *viz.,* appearance, colour, texture, taste and flavour on nine point scale. Sensory evaluation was done by a panel of 15 semi trained judges.

Statistical analysis

Paired 't' test was used to compare the physical parameters and nutrient composition of *besan* and foxtail millet *laddu.*

RESULTS AND DISCUSSION

From Table 1 it is observed that there was no significant difference in 'L' values of *laddu i.e. besan laddu* (53.56) and foxtail millet *laddu* (52.99). There was increase in the darkness with 50 per cent foxtail millet flour incorporated *laddu* however this was not significant. Value of 'a' were 13.14 and 14.32 for foxtail millet *laddu* and *besan laddu* respectively. Value of 'b' for foxtail millet *laddu* and *besan laddu* were 29.91 and 32.73 respectively. Weight of the foxtail millet *laddu* and *besan laddu* were 30.66 g and 33.66 g respectively. Volume of foxtail millet *laddu* was 36.13 and for *besan laddu* 39.66 ml. Circumference of foxtail millet *laddu* and *besan laddu* were 12.83 cm and 14.10 cm respectively. Statistical analysis showed that there was significant difference for colour 'a' and 'b' values, weight, volume and circumference in both the *laddus i.e. besan laddu* and optimised foxtail millet based *laddu.*

The proximate composition of *besan laddu* and foxtail millet *laddu* are depicted in the Table 2. Fat and protein content were significantly higher in *besan laddu i.e.* 21.49 and 13.55 g/100 g respectively when compared to foxtail millet *laddu*. It may be due to higher protein content in bengal gram dhal flour and more quantity ghee in *besan laddu* The moisture content was higher in *besan laddu* (0.45%) when compared to foxtail millet *laddu* (0.25%). However, there was no significant difference. The energy content was significantly higher in *besan laddu* (499.61 Kcal) when compared to foxtail millet *laddu* (471.60 Kcal). It is because of more ghee content in *besan laddu.* Crude fibre (2.64), ash (1.11) and carbohydrate (66.85) content was higher in foxtail millet *laddu* when compared to *besan laddu i.e* 0.56, 0.90 and 62.99 respectively. This is due to foxtail millet flour, which has higher crude fibre content. The results are in accordance to that of fiber enriched *laddu* developed by Yenagi *et al.* (2010) where there was increase in crude fibre with the addition of foxtail millet flour in the product.

The sugar content of *besan* and foxtail millet *laddu* is shown in the Table 3. The total sugar of foxtail millet *laddu* was higher 24.10 g as compared to *besan laddu* (21.79 g). The non-reducing sugar present in foxtail millet *laddu* and *besan laddu* was 22.91 and 20.53 per cent respectively. And the reducing sugar was 1.33 and 1.25 per cent in *besan* and foxtail millet *laddu* respectively. However, there was no significant difference found in total sugar, reducing sugar and non-reducing sugar in foxtail millet *laddu* and *besan laddu.*

The mineral content of foxtail millet *laddu* and *besan laddu* are depicted in the Table 4. The calcium and iron content of foxtail millet *laddu* were high 9.34 mg and 2.44 mg respectively compared to control *laddu* 8.27 mg and 2.44 mg respectively. However it was not significant. Copper was higher in foxtail millet *laddu* (0.81 mg/100 g) compared to *besan laddu* 0.05 mg/100 g but were not significant. Zinc and manganese were higher in *besan laddu* compared to foxtail millet *laddu*. However, difference were not

Table 1: Physical parameters of *besan laddu* and developed foxtail millet *laddu*.

Parameters	*Besan laddu*	Foxtail millet *laddu*	't' value
L#	53.56±0.35	52.99±0.05	2.74NS
a#	14.32±0.23	13.14±0.16	7.07**
b#	32.73±0.25	29.91±0.08	18.04**
Weight (g)	33.66±0.28	30.66±0.28	1.00**
Volume (ml)	39.66±0.28	36.13±0.32	0.81**
Circumference (cm)	14.10±0.17	12.83±0.15	0.69**

NS- Non significant.

**Significant at 0.01%.

Colour values (L, a and b).

Each value is mean of three replications.

Table 2: Proximate Composition of *besan laddu* and foxtail millet *laddu* .

Nutrient (%)	*Besan laddu*	Foxtail millet *laddu*	't' value
Moisture	0.45±0.01	0.25±0.04	6.90
Fat	21.49±0.10	17.52±0.46	14.51*
Protein	13.55±0.04	11.61±0.23	14.25*
Crude fibre	0.56±0.05	2.64±0.03	55.00*
Ash	0.90±0.02	1.11±0.02	12.15
Carbohydrate	62.99±0.07	66.85±0.40	16.40
Energy (Kcal)	499.61±0.47	471.60±2.33	20.3*

*Significant at 0.5%.

Each value is mean of three replications.

Table 3: Sugar content of *besan laddu* and foxtail millet *laddu.*

Sugars (%)	*Besan laddu*	Foxtail millet *laddu*	't' value
Total sugar	21.79±5.87	24.10±5.10	0.51NS
Reducing sugar	1.32±0.34	1.25±0.10	0.35NS
Non reducing sugar	20.53±5.55	22. 91±5.02	0.54NS

NS- Non significant.

Each value is mean of three replications.

Table 4: Mineral Composition of *besan laddu* and foxtail millet *laddu.*

Minerals (mg/100 g)	*Besan laddu*	Foxtail millet *Laddu*	't' Value
Iron	2.44±0.02	2.72±0.02	14.84NS
Calcium	8.27±0.04	9.34±0.46	2.82NS
Zinc	0.46±0.15	0.44±0.03	0.29NS
Copper	0.05±0.02	0.18±0.02	7.18NS
Manganese	0.64±0.03	0.6±0.03	0.27NS

NS- Non significant.

Each value is mean of three replications.

Table 5: Sensory scores of *besan laddu* and developed foxtail millet *laddu*.

Parameters	*Besan laddu*	Foxtail millet *laddu*	*'t'* value
Appearance	8.50±0.52	8.40±0.69	0.36NS
Colour	8.50±0.52	8.50±0.52	0.00NS
Texture	8.90±0.31	8.60±0.51	1.56NS
Taste	8.50±0.70	8.40±0.84	0.28NS
Flavour	8.60±0.51	8.50±0.52	0.42NS
Overall acceptability	8.50±0.52	8.50±0.52	0.00NS

NS- Non Significant.

significant. This may be attributed to the incorporation of foxtail millet flour which is a rich source of trace elements. Previous studies also report increase in mineral content of foxtail millet based products like muffin and *laddu* (Garwadhiremath, 2011 and Yenagi *et al.,* 2010).

Table 5 shows the sensory scores of developed foxtail millet and *besan laddu.* The score was 8.5 for the colour, flavour and overall acceptability of foxtail millet *laddu*. However for appearance and taste the score was 8.4. For texture the score was 8.6. Overall acceptability score of *besan laddu* was 8.5. Texture (8.9) of *besan laddu* score higher and then followed by the flavour (8.6). And for appearance, colour, taste the score was 8.5. However, there was no significant difference between the foxtail millet *laddu* and *besan laddu.* Roasting process enhances the colour and flavour of the foxtail millet and Bengal gram dhal flours (Sudha *et al.,* 2021). With regard to mouthfeel, in foxtail millet *laddu*, fibre texture can be felt whereas besan *laddu* has soft texture and just melts in the mouth. In some of the other value added products like foxtail millet based burfi, muffin, bread, vermicelli, pasta and extruded snacks upto 50 per cent incorporation of foxtail millet was carried out and were highly acceptable (Srivastava and Singh, 2003, Garwadhiremath 2011, Deshapande and Poshadri, 2011, Balloli *et al.,* 2014, Ranganna *et al.,* 2014).

CONCLUSION

Foxtail millet based *laddu* prepared were nutritious and rich in protein, fibre and trace minerals. Production of indigenous foxtail millet *laddu* as homemade processing unit can be recommended. This technology should be encouraged among the women entrepreneurs which is profitable and cost effective.

Conflict of interest

All authors declare that they have no conflict of interest.

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