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Development of Foxtail Millet (*Setaria italica*) based *Laddu*

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ABSTRACT

Background: Foxtail millet (*Setaria italica*) is the second-most widely planted species of millet. It is known for its health benefits. *Laddu* are ball-shaped sweets popular in the Indian Subcontinent. *Laddus* are made of flour, ghee and sugar with other ingredients that vary by recipe. They are often served at festive or religious occasions. Hence, an attempt was made to develop foxtail millet based value added *laddu*.

Methods: Optimization of foxtail millet flour, ghee, sugar and roasting time was carried out. Sensory evaluation was done by nine point hedonic scale.

Result: Standardization trials indicated that acceptable foxtail millet *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. Physical and descriptive qualities of prepared *laddus* were also carried out. The nine-point hedonic scale was used for sensory evaluation. The developed foxtail millet *laddu* was highly accepted.

Key words: Foxtail millet *laddu,* Optimization, Sensory evaluation, Physical and descriptive qualities.

INTRODUCTION

Traditional foods are developed through ages invented, modified, utilized and evolved to overcome the monotony in the diet. The traditional food of India has been widely appreciated for its extensive use of locally grown crops. Indian traditional food is known for its large assortment like sweet, savoury and spicy traditional foods. Further, the significance of traditional foods is more appreciable when their nutritive value is known. By virtue of diversity, India is blessed with many traditional foods specifically prepared for festivals, rituals and physiological conditions (Ananthanarayan *et. al.,* 2019). With improvement in food technology, convenience food and ready to eat foods are emerging in market.

Foxtail millet (*Setaria italica*) is nutritious and important underutilized grain, grown in various parts of India. It grows well even under adverse agro climatic conditions. Foxtail millet is a good source of protein (12.3 g/100 g), dietary fibre (14 g/100 g) and carbohydrates (60.9 g/100 g). Besides, it is rich in minerals (3 g/100 g) and phytochemicals (Gopalan *et al*., 2010). Foxtail millet is a good source of β-carotene (126-191 µg/100 g, Goudar *et al*., 2011).

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. Value addition to existing foods with foxtail millet is a simple and feasible way of enhancing nutritional values of foods and in turn the health benefits. The food products based on traditional food preparations easily become acceptable to people. Hence the present investigation is aimed to develop the foxtail millet incorporated *laddu*. Foxtail millet *laddu* may have a good scope for enhancing nutrition security.

MATERIALS AND METHODS

The present study was carried out in the Department of Food Science and Nutrition, University of Agricultural Sciences Dharwad Karnataka during the year 2018-19. The raw materials like foxtail millet, Bengal gram dhal flour, ghee and sugar powder were purchased from the local market of Dharwad. The millet grains were washed, rinsed, shade dried and milled from the local commercial milling machine. Standard recipe of *besan laddu* (control) include bengal gram dhal flour (150 g), ghee (75 g), sugar powder (128 g) and the roasting time 45 minutes.

For standardization of the foxtail millet based *laddu,* optimization for the incorporation of foxtail millet flour, addition of ghee, addition of sugar powder and roasting time was carried out.

1. Optimization for the incorporation of foxtail millet flour

Bengal gram dhal flour was replaced by foxtail millet flour at 25, 50, 75 and 100 per cent level in the standard recipe and all other ingredients were kept constant. Roasting time was kept constant 45 minutes.

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2. Optimization for the addition of ghee

The highly accepted *laddu* had the ingredients, bengal gram dhal flour (50%), foxtail millet flour (50%), ghee (50%) sugar powder (85%) and time taken for roasting was 45 minutes. To this, level of ghee incorporation was studied by adding the ghee at 5 per cent variation *i.e.* 60, 55, 50, 45 and 40 per cent.

3. Optimization for addition of sugar powder

The level of sugar powder incorporation in the highly accepted (by sensory evaluation) foxtail millet based *laddu* (after optimisation of ghee incorporation) was studied by adding the sugar powder at 5 per cent variation *i.e.* 95, 90, 85, 80 and 75 per cent.

4. Optimization for the roasting time

The time required for roasting was carried out at 5 min variation *i.e.* 55, 50, 45, 40 and 35 min. It was mainly done to compare the colour of the developed *laddu* to control.

After each optimization process, (*i.e.* with foxtail millet flour, ghee, sugar and roasting time) physical and descriptive qualities of *laddus* were observed. The weight of the roasted flour with ghee and sugar, number of *laddus* prepared, weight and volume of each *laddu* were noted.

Sensory evaluation

Sensory qualities of the value added foxtail millet based *laddu* was conducted in comparison with *besan laddu* (control). 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.

The results obtained in this study were analysed by the following statistical methods using SPSS statistical package (Version 16.0). All the analysis were performed in triplicate and the data was presented as mean ± SD. Paired 't' test was used to compare the sensory scores of *besan* and foxtail millet *laddu*.

RESULTS AND DISCUSSION

Laddus prepared by varying the addition of foxtail millet flour at 25, 50, 75 and 100 per cent to bengal gram dhal flour were evaluated for physical characters. And the other ingredients used were the ghee 75g and sugar powder 128g (Table 1). Increased addition of foxtail millet flour from 25 to 100 per cent decreased the final weight of flour mix from 337.33 to 314.66 g. It may be because of lower bulk density of foxtail millet flour (0.63 g/cm^3) (Sudha *et al.* 2021). Increased addition of foxtail millet flour had increased the grainy texture and decreased the stickiness in *laddu.* It was also reported by Kamara *et al*. (2009) that the low bulk density of foxtail millet flour was due to its lower particle density and large particle size. *Laddu* prepared by addition of foxtail millet flour (upto 75 per cent) had attained the golden brown colour. Bengal gram dhal flour had the very fine particle size and is known for its binding property. The *laddu* prepared by 100 per cent of foxtail millet flour had the creamish white colour, was grainy and could not hold the shape for long time. This is due to the large particle size, fibre content (7.92 g/100 g) and lower oil absorption index (1.02 g/g) of the foxtail millet flour (Sudha *et al* 2021).The lower oil absorption capacity of foxtail millet flour might be due to low hydrophobic proteins which show superior binding of lipid (Kinsella, 1979). The time of roasting was kept constant *i.e.* 45 minutes. The weight of each *laddu* decreased with incorporation of foxtail millet flour and therefore volume also. Yenagi *et al*. (2010) also reported to develop the foxtail millet based *laddu* wherein the 50 per cent foxtail millet flour was incorporated .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).

From Table 2 it was observed that, with increased ghee addition, there was an increase in the weight of roasted flour mix that ranged from 328.66 to 349.33 g. On variation of ghee quantity, colour and consistency of roasted flour mix was altered. The descriptive qualities also affected the organoleptic characteristics. Increased addition of ghee (50-60%) made roasting easy but the round shape of the *laddu* could not be retained. There was slight difficulty in the roasting in case of 45 per cent ghee addition. Similar findings were reported by Garwadhiremath, (2011) in the optimization of foxtail millet based muffin where 5 per cent decrease in addition of fat was made as foxtail millet flour has less oil absorption capacity.

Bengal gram dhal flour and foxtail millet flour in 50:50 proportion with 68 g (45%) of ghee and 45 minutes roasting time was used in preparation of *laddu* with varying quantity of sugar powder which ranged from 143 to 113 g (*i.e.* 95 to 75%). Sugar is a principle ingredient in preparation of sweet products and its role extends for providing energy and sweetness. Table 3 presents that, with increased addition of sugar powder there was increase in the weight of roasted flour mix that is ranged from 317.66 g to 347.66. The weight (31.25 g to 34.20) and volume (36.75 to 40.20 ml) of each *laddu* increased with increased addition of sugar powder. As there was increase in the addition of sugar powder, the flour mix resulted in powdery mixture which made fair handling of roasted mix. With the addition of sugar, sweetness of *laddu* increased and the intensity of the colour reduced. The prepared *laddu* were not acceptable till the 85 per cent addition because of more sweetness. Addition of 75 per cent sugar powder to the roasted flour (with ghee) were found to be acceptable.

Laddus were prepared from 150 g flour mix containing 1:1 proportion of Bengal gram dhal flour and foxtail millet flour, ghee (68 g), sugar powder (113 g) and with roasting time variation from 35 to 55 minutes. As the roasting time increased there was decrease in the weight of the flour mix

Table 1: Physical and descriptive qualities of *laddu*# prepared by varying proportion of foxtail millet flour to bengal gram dhal flour.

Flour (%) Bengal gram dhal : Foxtail millet	Flour (gm) Bengal gram dhal : Foxtail millet	Weight of the roasted flour with ghee and sugar (g)	Mean weight of *laddu* (g)	Mean volume of *laddu* (ml)	Bulk density (g/cm^3)	Descriptive qualities of *laddu*	
						Sensory attributes	*Laddu* binding property
100:0	150:0	339.33±0.57	33.40±0.39	38.70±1.08	0.86	Golden brown, more sticky	Excellent
75:25	113:37	337.33±1.15	32.20±0.25	39.10±0.51	0.82	Golden brown, moderate stickiness	Excellent
50:50	75:75	335.66±0.57	32.40±0.39	37.90±0.39	0.85	Golden brown, less stickiness	Very good
25:75	37:113	329.66±0.57	31.50±0.47	37.00±0.47	0.85	Golden brown, slightly grainy	Good
0:100	0:150	314.66±0.57	30.40±0.45	35.80±0.48	0.85	Creamish white, more grainy	Poor

Note: #*Laddus* prepared by 150 g of flour mix; Other ingredients: Ghee- 75 g; Sugar powder- 128 g; Roasting time- 45 min.
Number of *laddus* prepared (in each flour variation): 10.
Each value is mean of three replications.

Table 2: Physical and descriptive qualities of *laddu*# prepared by varying quantity of ghee.

Ghee (%)	Ghee (g)	Weight of the flour after roasting (g)	Mean weight of each *laddu* (g)	Mean volume of each *laddu* (ml)	Bulk density (g/cm^3)	Descriptive qualities of *laddu*
40	60	328.66±0.50	31.70±0.25	37.15±0.04	0.85	Very difficult to roast, was difficult to bind, easily breaks
45	68	332.66±0.57	32.15±0.24	37.65±0.24	0.85	Slight difficulty in roasting, good binding and retains the shape, breaks moderately
50	75	335.66±0.57	32.70±0.25	38.20±0.25	0.85	Easy to roast, could not retain the shape
55	83	346.33±0.57	33.70±0.25	39.70±0.25	0.85	Easy to roast, could not retain the shape
60	90	349.33±0.57	34.20±0.25	40.20±0.25	0.85	Easy to roast, cannot retain round shape

Note: # *Laddus* prepared by 75 g of bengal gram dhal flour and 75 g foxtail millet flour; Other ingredients: Sugar powder- 128 g; Roasting time- 45 min.
Number of each *laddu*s prepared (in each ghee variation): 10. Each value is mean of three replications.

Table 3: Physical and descriptive qualities of *laddu*# prepared by varying quantity of sugar powder.

Sugar powder (%)	Sugar powder (g)	Weight of the flour after roasting (g)	Mean weight of each *laddu* (g)	Mean volume of each *laddu* (ml)	Bulk density (g/cm^3)	Descriptive qualities of *laddu*	
						Sensory attributes	*Laddu* binding property
75	113	317.66±0.57	31.25±0.26	36.75±0.26	0.85	Golden brown, tastes acceptable	Very good No powdery mixture
80	120	326.33±0.57	31.70±0.25	37.20±0.25	0.85	Golden brown, tastes acceptable	Fair powdery mixture
85	128	332.66±0.57	32.70±0.25	38.20±0.25	0.85	Light golden brown, too sweet	Fair powdery mixture
90	135	339.66±0.57	32.60± 0.77	38.30±1.03	0.85	Light golden brown, too sweet	Fair powdery mixture
95	143	347.66±0.57	34.20±0.25	40.20±0.25	0.85	Light golden brown, too sweet	Fair powdery mixture

Note: #*Laddus* prepared by 75 g of bengal gram dhal flour and 75g foxtail millet flour; Other ingredients: Ghee 68g; Roasting time- 45 min. Number of *laddus*prepared (in each ghee variation): 10; Each value is mean of three replications

Table 4: Physical and descriptive qualities of *laddu** prepared by varying the roasting time.

Roasting time (min.)	Weight of the flour after roasting (g)	Mean weight of each *laddu* (g)	Mean volume of each *laddu* (ml)	Bulk density (g/cm^3)	Descriptive qualities of *laddu*	
					Sensory attributes	*Laddu* binding property
35	319.00±1.15	29.85±0.62	34.95±0.83	0.85	Light yellowish	Good
40	317.33±1.15	29.90±0.61	35.00±0.81	0.85	Golden brown (colour nearly matches the control)	Very Good
45	315.00±1.15	29.95±0.59	35.05±0.79	0.85	Brownish	Very Good
50	313.33±1.15	29.95±0.59	35.05±0.79	0.85	Dark brown, charred	Good
55	311.33±1.15	29.80±0.25	34.80±0.25	0.85	Dark brown, charred	Good

Note: **Laddus* prepared by 75 g of bengal gram dhal flour and 75 g foxtail millet flour; Other ingredients: Ghee- 68 g; Sugar powder- 113 g.
Number of *laddus* prepared (in each roasting time variation): 10. Each value is mean of three replications.

(317.33 to 311.33 g). There was not much change in the weight and volume of *laddu* prepared. Increase in the roasting time resulted in the charring of the roasted flour mix and therefore the colour resulted was dark brown. *Roasting* brings change in colour and flavour through dextrinization and Maillard reaction. However 40 minutes roasting time was found to be acceptable as the colour turned out golden yellow (comparable to control) *i.e.* colour obtained after roasting of flour mix with ghee and addition of sugar powder. But there was lightness in colour of *laddu* when roasted for 35 minutes. Dough handling *i.e.* binding property was very good in 45 and 40 minutes roasting time. And it was good in 35 and 50 minutes roasting time (Table 4). However, it was observed that roasting for 40 minutes found to be optimal for development of foxtail millet *laddu* as the colour of the developed *laddu* was similar to the control and could retain the round (ball) shape.

The *Besan laddu* (control) was prepared by 100 per cent bengal gram dhal flour (150 g), ghee 75 g (50%), sugar powder 128 g (85 %) and the time taken for roasting was 45 minutes. The optimised foxtail millet based *laddu* was prepared by incorporating the foxtail millet flour (75g) to bengal gram dhal flour (75 g), ghee (68 g) and sugar powder (113 g). The time taken for roasting was 40 minutes. Fig 1 shows the Besan *laddu* and developed foxtail millet *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 and while tasting (mouth feel) the texture of fibre was felt. Overall acceptability score of *besan laddu* was 8.5. Texture (8.9) of *besan laddu* score was higher because of its smoothness in mouth feel and presence of fibre in less in bengal gram dhal flour compare to foxtail millet flour (Sudha *et al.* 2021) and then followed by the flavour (8.6). And for appearance, colour, taste the score was 8.5 (Table 5).

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	0.36^{NS}
Colour	8.50±0.52	8.50 ± 0.52	0.00^{NS}
Texture	8.90±0.31	8.60 ± 0.51	1.56^{NS}
Taste	8.50±0.70	8.40 ± 0.84	0.28^{NS}
Flavour	8.60±0.51	8.50 ± 0.52	0.42^{NS}
Overall acceptability	8.50±0.52	8.50 ± 0.52	0.00^{NS}

NS – Non Significant.

a. *Besan laddu*

b. Developed foxtail millet *laddu*

Fig 1: a. *Besan Laddu* and Developed Foxtail millet *Laddu.*

CONCLUSION

From the study it was concluded that, the recipe of foxtail millet based *laddu* differed from *besan laddu*. At present there is demand for ready to eat foods and therefore it has opened challengeable avenue to start production of such foods at commercial scale to benefit innumerable population and it can provide ample opportunity of employment for the enthusiastic entrepreneurs. Production of indigenous foxtail millet *laddu* as homemade processing unit can be recommended.

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