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Standardization and development of gluten-free Millet *Laddoo*: Sensory and nutritional profile

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Abstract
The present investigation was aimed to development gluten-free millet *laddoo* with utilization of different proportions of sorghum flour, pearl millet flour and finger millet flour. To standardize the processing and analyse the characteristics of gluten-free millet *laddoo viz*, chemical, sensory and textural property of gluten-free millet *laddoo*. The formulation and different formulation were carried out using sorghum flour, pearl millet flour and finger millet flour in preparation of gluten-free millet *laddoo*. Prepared gluten-free millet *laddoo* then evaluated for sensory properties with respect to colour and appearance, body and texture, taste and flavour, and overall acceptability using 9-point hedonic scale. The results revealed that gluten-free millet *laddoo* prepared with utilization of sorghum flour, pearl millet flour and finger millet flour (T_2) secured highest score (i.e. 8.5) was superior as compared to rest of samples. It was found that gluten-free millet *laddoo* prepared with sorghum flour, pearl millet flour and finger millet flour was rich source of fiber and micronutrients including calcium, iron, phosphorus. The cost of the dry ingredients for preparing gluten-free millet *laddoo* per 100 g were Rs.20.625 for T_0, Rs.31.33 for T_1, Rs.30.33 for T_2 and Rs.31.76 for T_3. Thus, it can be concluded that utilization of Sorghum flour, Pearl millet flour and Finger millet flour can be utilized for preparation of different food products which enhances the Nutritional Content and improves Sensory Acceptability.

Keywords: Hedonic scale, sorghum, pearl millet and finger millet, nutritive value, cost

Introduction
Sorghum or broomcorn is a genus of about 25 species of flowering plants in the grass family (Poaceae). Some of these species are grown as cereals for human consumption, in pastures for animals as fodder, and as bristles for brooms (Zhang *et al*.,2019) [2]. India ranks fifth in total sorghum production with 4.23 million tonnes grown in an area of 3.90 million hectares in 2021-22, whereas in kharif 2022-23, sorghum production was 1.69 million tonnes (in an area of 2.94 million hectares. Sorghum grain is a nutritious food rich in protein, dietary fiber, B vitamins, and minerals.

Pearl millet (*Pennisetum glaucum*) is the most widely grown type of millet. It has been grown in Africa and the Indian subcontinent since prehistoric times. In India, pearl millet is the fourth most widely cultivated food crop after rice, wheat and maize. It occupies an area of 6.93 million hecters with an average production of 8.61 million tones and productivity of 1243 kg/ha during 2018-19 (Prakash *et al*.,2023) [8]. Pearl Millet is a profoundly nutritious and easy to digest cereal grain. Being non-glutinous makes it a healthy option for people with a gluten allergy and celiac disease. Perfect for Celiac disease and gluten intolerance – patients with celiac disease and gluten intolerance can opt for a pearl millet-based diet as it is gluten-free and easily tolerated by everyone (Sagar *et al*.,2023) [8].

Finger millet (Ragi) is a type of millet that is commonly grown in parts of the world with a particularly hotter climate such as Africa and South Asia. In India, Ragi has always been a significant part of the food culture for generations. Ragi is also known as Nachni in some parts of India, whereas its western name is Finger Millet. The Ragi grain is well-known for its nutritional density like many other types of millets. Ragi flour is considered a superfood and was once consumed widely in Indian homes. However, its popularity had dwindled in favor of more commonly available types of grain flours. (Patil *et al*., 2023) [9].

Materials and Methods
Experimental Site
The present study was carried out in the Food lab and Nutrition Research Laboratory, Department of Food, Nutrition and Public Health, Ethelind College of Community Science,

Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj U.P.

Procurement of raw materials: The raw materials like Sorghum, Pearl millet, Finger millet flour and other raw ingredients were purchased from local market of Prayagraj.

To standardized Gluten-free flours-Millets in different proportional was tried to get good composition of flours for cooking. This trial was conducted to get best ratio of flour. It was finalized after conducting trials in ratio given.

	R_1	R_2	R_3
Sorghum millet flour	50 gm	60 gm	30 gm
Pearl Millet flour	40 gm	30 gm	60 gm
Finger Millet flour	10 gm	10 gm	10 gm

Standardization and Development of gluten-free millet *laddoo*:- A standard recipe is one in which the amount and proportion of the ingredients and method will consistently produce a high quality product. The ingredients are carefully balanced for the number of servings a recipe has to yield. Formulation was prepared by mixing sorghum flour, pearl millet flour and finger millet flour in different proportions. Figure 1. depicted different combinations of flours of sorghum flour, pearl millet flour and finger millet flour.

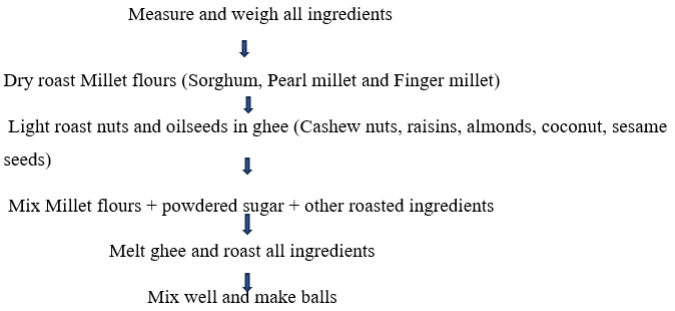

Fig 1: Flow diagram of the preparation of Gluten-free Millet *Laddoo*

Sensory evaluation of the developed food products: - Sensory evaluation of the food products for their acceptability was done by a panel of 5 judges. The score card based on the 9-point Hedonic Scale was used for sensory evaluation (B. Srilakshmi, seventh edition, 2018).

Statistical Analysis: The data was statistically analyzed by using appropriate statistical analysis of variance (ANOVA) and critical difference technique. A significant difference between the treatments was determined by using CD (Critical Difference) test. "t" test was performed for comparing the difference in nutritional content between the control and the best treatment of the nutritionally enriched food products (Gacula and Singh 2008) [4].

Results and Discussion

Table 1: Average sensory score of different parameters in control and experimental treatments of Gluten-free Millet *Laddoo*

Experimental Treatment	Colour and Appearance	Body and Texture	Taste and Flavour	Overall Acceptability
T_0	7.2	7	7.5	7.4
T_1	7.5	7.2	7	7
T_2	8.1	8	8.5	8
T_3	7	7.4	7	7
F cal	17.8	35.3	26.3	31.6
F tab	4.75	4.75	4.75	4.75
CD ($P \leq 0.05$)	0.56	0.78	0.88	0.97
S.A.	S*	S*	S*	S*

S.A = Statistical Analysis, S * = Significant, NS* * = Non-Significant, ($p \leq 0.05$)

Results of sensory evaluation of gluten-free millet *laddoo* prepared with sorghum flour, pearl millet flour and finger millet flour presented in revealed that the overall acceptability of gluten-free millet *laddoo* ranged from 8-7. This indicated that the recipes were found under the category of "liked moderately to liked very much. Standard gluten-free millet *laddoo* exhibit highest scores for all sensory attributes i.e. 8, (appearance), 8.1, (color), 8, (texture), 8.5, (flavour), 8.5, (taste) and 8, (overall acceptability) as compared to gluten-free millet *laddoo* prepared with sorghum flour, pearl millet flour and finger millet flour. However, utilization of sorghum flour, pearl millet flour and finger millet in gluten-free millet *laddoo* upto 100 per cent level maintains like very much like on the basis of 9-point hedonic scale. Statistical data revealed that there was significant difference in mean rank in terms of taste at ($p <= 0.05$) and overall acceptability at ($p <= 0.01$) significant difference was observed in terms of colour and appearance, body and texture and taste and flavour and overall acceptability. It was observed that all experimental treatments of millet ladoo showed increased intensity of colour because of the roasting method applied on the sorghum, pearl millet flour and finger millet flour for combining the *ladoo.* Addition of jaggery powder also improved the appearance of millet laddus and made it appealing. According to **(**Sudha *et al*., 2021) [6] colour values of flour decreased after roasting indicated that the lightness of the flour decreased and darkness increased. Dark browning reactions such as maillard reaction and degree of cooking and pigment degradation that take place during the starch extraction process affects the overall appearance of products.

Table 2: Estimation of nutrients content and mineral content of "Gluten -free Millet *Laddoo*" by using t-test

Nutrients	T_0	T_2	(Difference)($T_2 - T_0$)	t. cal	t. tab	
Moisture (%)	10.2	12.84	2.64	3.1	2.447	S*
Protein (g)	11.3	12.845	2.645	4.8	2.447	S*
Fat (g)	13.15	11.8	1.35	2.67	2.447	S*
Fiber (g)	2.055	20.02	17.965	26.07	2.447	S*
Carbohydrate(g)	84.75	109.97	25.22	30.5	2.447	S*

Energy (Kcal)	582.5	584.1	1.6	2.50	2.447	S*
Calcium (mg)	78	163.73	85.73	104.4	2.447	S*
Iron (mg)	3.53	8.0715	4.5415	5.50	2.447	S*

S * = Significant, NS* * = Non-Significant, S.A =

Statistical Analysis

Gluten-free millet *laddoo* is determined their nutrient content from nutritive value of Indian food book published from NIN by ICMR (C. Gopalan *et al*.,2018) [3]. The above Table 2. shows the "t" value of control and best treatment for gluten-free millet *laddoo.* The table 2. indicates a significant difference between the nutrient content of the control (T_0) and the best treatment (T_2) as the calculated value of "t" which was found to be for protein content, 4.8 for fat content, 2.67 for carbohydrate content, 30.5 for calcium content and 104.4 for iron content was higher than the tabulated value of "t" which is 2.447 at 5 percent probability level. It is quite obvious from the above Table 2. that because of utilization of Sorghum flour, Pearl millet flour and Finger millet flour a in different ratios resulted in improved nutritional content in gluten-free millet *laddoo*. Kavali. S *et al.,* (2020) [10] studied the Effect of cooking on nutritional and anti-nutritional components of millet incorporated products which shows similar results i.e their Millet incorporated *laddoo* contained moisture (4.3%) protein (18.3%) fat (20.4%) crude fibre (4.26%) ash (2.28%) and calcium (100.6%) iron (6.46%). In Asia, the millet grain is a high-protein, high-fiber substitute for wheat that is also convenient to use in traditional Indian dishes. The Indian Subcontinent is known for its ball shaped *laddoo.* Flour, sugar or jaggery, and other ingredients vary from recipe to recipe while making laddus. It is frequently offered during celebratory or religious occasions. Besan, a chickpea flour, rava, a wheat semolina, and ground coconut flour are common ingredients in *laddoo.* The Indian diet finds in millet grain a culinary acceptable high protein, high fiber, alternative to wheat, and easy to incorporate into the traditional foods. Sweets are acceptable to customers and can be consumed anywhere, at any time. Hence, the multi-cereal millet *laddoo* would be a traditional sweet that consumers would find favourable, affordable, and nutritious. (Naga *et al*., 2017) [7].

Table 3: Cost of the raw ingredients of the Gluten-free Millet *Laddoo* /100 g.

Ingredients	Actual rate/kg (Rs.)	T_0		T_1		T_2		T_3	
		Amt (g)	(Rs.)	Amt (g)	(Rs.)	Amt (g)	(Rs.)	Amt (g)	(Rs.)
Gram flour	100	100	10	-	-	-	-	-	-
Sorghum flour	120	-	-	45	5.4	35	3.6	55	6.6
Pearl millet flour	80	-	-	45	3.6	55	4.4	35	2.8
Finger millet flour	80	-	-	10	0.8	10	0.8	10	0.8
Coconut powder	260	-	-	5	1.3	5	1.3	5	1.3
Sesame seeds	380	-	-	2	0.76	2	0.76	2	0.76
Cashew	560	-	-	5	2.8	5	2.8	5	2.8
Almonds	570	-	-	5	2.85	5	2.85	5	2.85
Jaggery	108	-	-	40	4.32	40	4.32	40	4.32
Ghee	475	20	9.5	20	9.5	20	9.5	20	9.5
Sugar	44	25	1.125	-	-	-	-	-	-
Total			20.625		31.33		30.33		31.76

This above Table 3. shows the cost of the raw materials for preparing, gluten-free millet *laddoo* /100 g was Rs.20.625 for T_0, Rs.31.33 for T_1, Rs.30.33 for T_2, Rs.31.76 for T_3. It is therefore concluded that T_3 had the highest cost of production followed by T_2, T_1, and T_0 being the cheapest among all the treatments because of the incorporation level of sorghum flour, pearl millet flour and finger millet flour as they increased the price marginally.

Conclusion

This study has demonstrated that addition of increasing levels (100%) of sorghum flour, pearl millet flour and finger millet flour in the gluten-free millet *laddoo* affected the quality of sensory attributes. Gluten-free millet *laddoo* with 100% sorghum flour, pearl millet flour and finger millet flour has highest acceptability. The findings of the present study may help in developing commercial process for effective utilization of sorghum flour, pearl millet flour and finger millet flour especially for preparation of gluten-free millet *laddoo*. So it can be inferred from the present study that the gluten-free millet *laddoo* developed by using sorghum flour, pearl millet flour and finger millet flour was acceptable. Therefore, results suggest that there is a great scope for use and marketing of value-added gluten-free millet *laddoo* using sorghum flour, pearl millet flour and finger millet flour and it can be concluded that sorghum flour, pearl millet flour and finger millet flour can be utilized for achieving food and nutritional security for nation.

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