ISSN Print: 2664-844X
ISSN Online: 2664-8458
NAAS Rating (2025): 4.97
IJAFS 2025; 7(8): 305-307
www.agriculturaljournals.com
Received: 16-05-2025
Accepted: 18-06-2025

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Formulation and sensory evaluation of millet based finger food (sticks)

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DOI: https://www.doi.org/10.33545/2664844X.2025.v7.i8e.626

Abstract
The growing demand for nutritious and convenient snack foods underscores the need for healthier alternatives to conventional refined flour-based products. This study focused on the development of a millet-based finger food 'sticks' formulated using a composite flour blend of sorghum, buckwheat and cornflour in a ratio of 50:25:25. The product was evaluated through sensory analysis and shelf-life studies. Organoleptic assessment by a panel of ten trained members revealed high acceptability across parameters including color (8.0), flavor (8.2), taste (8.1), texture (7.8) and appearance (8.1), with an overall acceptability score of 8.4 on a nine-point hedonic scale. The sticks maintained sensory quality over 30 days of storage at ambient temperature, with only minimal, statistically non-significant changes observed. The findings demonstrate the feasibility of incorporating underutilized millet grains into popular snack formats, offering both nutritional benefits and consumer appeal. The study highlights the potential of millets in promoting sustainable, health-oriented and shelf-stable snack innovations.

Keywords: Millet-based product, sorghum, buckwheat, sensory evaluation, shelf life

Introduction
In recent years, the increasing pace of urbanization, lifestyle-related time constraints and the growing number of nuclear families have led to a marked rise in the consumption of convenience foods. These ready-to-eat or easy-to-prepare products offer practicality and time-saving benefits but often come at the cost of nutrition. Most commercially available snack items are made using refined wheat flour, trans fats, excessive salt and synthetic additives, contributing to a range of health concerns including obesity, type 2 diabetes and cardiovascular diseases (Sarita & Singh, 2016; Saxena *et al.,* 2018) [6, 7]. There is an urgent need for reformulating snack foods using nutrient-dense, sustainable and functional ingredients.

Millets have emerged as promising alternatives in this context. Known for their superior nutritional profile and drought tolerance, millets are rich in complex carbohydrates, dietary fiber, essential amino acids, vitamins (particularly B-complex) and minerals such as calcium, magnesium, iron and zinc. In particular, sorghum (*Sorghum bicolor L. Moench*) is valued for its antioxidant compounds including tannins and flavonoids, which have been linked to reduced risks of chronic diseases (Awika & Rooney, 2004; Kushi *et al*., 1999) [2, 4]. Similarly, buckwheat (*Fagopyrum esculentum*), though botanically a pseudocereal, boasts a high-quality protein with a well-balanced amino acid profile and contains health-promoting compounds such as rutin, quercetin and D-chiro-inositol, making it beneficial for managing diabetes and cardiovascular conditions (Zhang *et al*., 2007) [10].

The inclusion of such traditional grains into mainstream processed food formulations can address the dual challenge of malnutrition and non-communicable diseases. Buckwheat and sorghum are gluten-free, making them suitable for individuals with celiac disease or gluten sensitivity. Their use also supports dietary diversity and sustainability, as these crops are climate-resilient and require fewer agricultural inputs compared to rice and wheat (Taylor & Emmambux, 2008) [9]. Despite the growing awareness of millets' nutritional and ecological benefits, their integration into popular snack products remains minimal. A major hurdle is the perceived sensory inferiority of millet-based foods compared to conventional wheat or rice-based products.

However, with advancements in food processing, recipe optimization, and ingredient blending, it is possible to create acceptable and appealing millet-based convenience foods. This study aimed to develop and evaluate a millet-based finger food 'sticks' made using a composite flour blend of sorghum, buckwheat, and corn. The product was designed to meet modern consumers' demand for quick, tasty and health-oriented snacks. The research focused on organoleptic evaluation and shelf-life assessment to determine the product's sensory quality and storage stability under ambient conditions. The successful formulation of such snacks can help elevate the consumption of traditional grains, support farmers growing underutilized crops and promote better public health outcomes.

Materials and Methods

Procurement and Processing of Raw Material

Sorghum, buckwheat and cornflour were procured from Bikaner, Rajasthan. Grains were washed thoroughly with tap and distilled water, shade-dried for 2–3 days at room temperature (27 ± 3°C) and ground using a laboratory grinder. Flours were sieved (100-mesh) and stored in airtight containers (Agrahari & Dunkwal, 2012) [1]. Composite flour was prepared in a ratio of 50 percent sorghum, 25 percent buckwheat and 25 percent cornflour based on preliminary trials for sensory optimization.

Formulation of Millet-Based Stick

For the preparation of the millet-based finger food sticks (Table 1.), the standardized millet based flour was first sieved to ensure a uniform texture. It was then blended with baking soda, carom seeds (*ajwain*), salt and a specified quantity of oil. Water was gradually added and the mixture was kneaded into soft and elastic dough. The dough was then covered and allowed to rest for 15–20 minutes at room temperature. Post resting, the dough was shaped into uniform sticks using a hand-operated extruder fitted with a nozzle, which provided consistent dimensions and surface texture. The formed sticks were then deep-fried in moderately heated oil over a medium flame until they turned golden brown and developed a crisp texture. After frying, the sticks were drained on absorbent paper to remove excess oil and allowed to cool completely before packaging. The final appearance of the developed millet-based sticks is illustrated in Plate 1.

Table 1: Ingredient and amount used in the development of Sticks

S. No.	Ingredient	Amount (g/ml)	Percentage (%)
1.	Millet based flour	100	67.57
2.	Carom seed	0.5	0.34
3.	Red chilli powder	3	2.03
4.	Common salt	4	2.70
5.	Baking soda	0.5	0.34
6.	Oil	40	27.03

Plate 1: Stick

Organoleptic evaluation of the developed product

The developed product was standardized through organoleptic evaluation by a panel of ten selected members from the College of Community Science, SKRAU, Bikaner. Panellists were carefully selected and screened using the threshold test (Potter, 1987) [5], ensuring their capability, willingness and reliability in sensory analysis. Attributes such as color, appearance, aroma, texture, taste and overall acceptability were evaluated using a nine-point hedonic scale, where 1 indicated "dislike extremely" and 9 indicated "like extremely" (Swaminathan, 1987) [8]. All samples were served in coded, identical containers under controlled, distraction-free conditions to minimize external bias and ensure consistency of evaluation.

Shelf-Life Study

To evaluate product stability, the developed sticks were packed in high-density polyethylene (HDPE) pouches and stored at ambient temperature for 30 days. Sensory evaluations were conducted on the 0th, 15th and 30th day of storage using the same panel and nine-point hedonic scale (Swaminathan, 1987) [8]. Attributes assessed included color, flavor, taste, texture, appearance and overall acceptability. This evaluation aimed to assess the effect of storage on sensory quality over time.

Statistical Analysis

Data were analyzed statistically as per Gupta (2000) [3]. Arithmetic mean, standard deviation, standard error of mean and critical difference at 5 percent significance were calculated to interpret the results accurately.

Result and Discussion

Organoleptic evaluation of Sticks

Product development plays a key role in promoting consumer acceptability and sensory quality of value-added food items. In this study, millet-based finger food sticks were developed using a composite flour blend comprising sorghum, buckwheat and corn flour. Sensory evaluation was conducted to assess key attributes including color, flavor, taste, texture, appearance and overall acceptability. The sensory results (Table 2) revealed favorable mean scores across all parameters. The sticks scored 8.0 for color, 8.2 for flavor, 8.1 for taste, 7.8 for texture, and 8.1 for appearance, with an overall acceptability score of 8.4 placing them in the "liked extremely" category. These scores highlight the product's strong potential for consumer acceptance and commercial viability.

Table 2: Organoleptic Evaluation of Millet-based Sticks

Mean scores of sensory attributes					
Colour	Flavour	Taste	Texture	Appearance	Overall Acceptability
8.00±0.00	8.20±0.42	8.10±0.32	7.80±0.42	8.10±0.32	8.40±0.52

Values are mean ± SD of ten panelist

Shelf life evaluation of Sticks

Shelf-life analysis is essential for determining the commercial viability and consumer appeal of food products. The sensory characteristics of millet-based sticks were consistently retained throughout the 30-day ambient storage period. As shown in Table 3, the product maintained high scores across all attributes, with overall acceptability recorded at 8.3 on day 0, 7.9 on day 15, and 7.8 on day 30.

Minor variations in the mean scores were observed, but all changes were statistically non-significant ($p > 0.05$), indicating that the product retained acceptable sensory characteristics and remained within the "liked moderately" to "liked extremely" category throughout the storage period.

Table 3: Shelf-Life Evaluation of Millet-based Sticks

Mean scores of sensory characteristics on a nine-point scale						
Storage Days	**Colour**	**Flavour**	**Taste**	**Texture**	**Appearance**	**Overall Acceptability**
0 Day	8.10 ± 0.32	7.90 ± 0.32	8.20 ± 0.42	7.90 ± 0.32	8.30 ± 0.48	8.30 ± 0.48
15 Day	7.90 ± 0.57	7.80 ± 0.42	7.80 ± 0.42	7.80 ± 0.42	8.20 ± 0.42	7.90 ± 0.57
30 Day	7.80 ± 0.42	7.70 ± 0.48	7.80 ± 0.42	7.80 ± 0.42	7.90 ± 0.32	7.80 ± 0.42
SEm	0.15	0.16	0.17	0.16	0.15	0.17
CD (5%)	NS	NS	NS	NS	NS	NS

Values are mean ± SD of ten panellists. NS: Non-significant

Conclusion

Millet-based sticks formulated from a composite flour of sorghum, buckwheat and cornflour demonstrated excellent organoleptic properties and consumer appeal. Sensory attributes such as flavor, texture, and appearance were rated highly, with the product falling under the "liked extremely" category. Over a storage period of 30 days, the sticks retained their sensory characteristics with no statistically significant decline in quality. These findings support the inclusion of underutilized millets in the development of innovative, nutritious and gluten-free snack alternatives that are shelf-stable and market-ready. The study underlines the potential of incorporating sustainable and health-promoting grains into popular snack formats to meet both nutritional and consumer demands.

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