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Studies on standardization, sensory evaluation and chemical composition of Millet-gram Cookies

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Abstract
This study focuses on the development and quality evaluation of milletgram cookies, formulated to provide both sensory appeal and enhanced nutritional benefits. The cookies were prepared by using millet flour, gram flour, jaggery and selected functional ingredients and were optimized for appearance, flavor, texture, taste and overall acceptability. The study deals with preparation of value added products (cookies) with incorporation of various percent of sorghum flour, pearl millet flour, green gram flour, roasted Bengal gram flour. The sensory evaluation of these millet gram cookies was carried out using 9-point Hedonic scale. The good quality cookies can be prepared by incorporation of sorghum flour, pearl millet flour, sattu flour and roasted Bengal gram flour were acceptable without affecting organoleptic quality. Cookies prepared by use of 21% sorghum flour, 6% pearl millet flour, 12% green gram flour and 8% roasted Bengal gram flour treatment (T1) contains 5.0 ± 0.058% moisture, 1.83 ± 0.167% ash, 11.92 ± 0.33% protein, 13.03 ± 0.08% fat, 3.83 ± 0.12% fiber and 64.39 ± 0.20% carbohydrates. Overall, the optimized milletgram cookies demonstrated excellent sensory characteristics, enhanced nutritional profile, and satisfactory shelf-life, suggesting their potential as a functional, health-promoting snack option.

Keywords: Millet–gram cookies; Sugar-less cookies, Gluten-free bakery product; Sorghum cookies, Sattu powder, Nutritional enhancement; Lifestyle disease control

Introduction
Millets, known as "nutri-cereals," have gained significant attention for their resilience under adverse climatic conditions and their superior nutritional profile. They are rich in dietary fiber, essential amino acids, minerals such as iron, calcium, and zinc, and bioactive compounds with antioxidant properties (Devi *et al*., 2014) [4]. The inclusion of millets in bakery products like cookies not only diversifies dietary options but also supports sustainable agriculture by promoting underutilized grains (Gopalan *et al*., 2012) [6].

In many countries, biscuits are considered as ready-to-eat, convenient and cheap food product that is likely consumed by every age group people. Biscuits are rich in fat and carbohydrates; hence they can be referred to as energy giving food as well as good source of protein and minerals. In general, the ingredients/ raw materials used in the manufacture of biscuits are: wheat flour, margarine (shortening), sweeteners (sugar), leavening agents, eggs, milk, salt and flavours. Whole grains serve as a preferred carbohydrate source in a modern Indian diet to achieve a balance of macronutrients, micronutrients, fibers, and phytochemicals for optimal health promotion. The five most common ancient grains that have the potential to be used more in Indian cooking are: amaranth, barley, pearl millet, finger millet, and sorghum. Use of these grains may also allow individuals to make healthier dietary changes that align with cultural tradition. India is the largest producer of many kinds of coarse cereals/millets which includes pearl millet, sorghum, oat, finger millet, foxtail millet etc. Among these, pearl millet and sorghum are unique millets which are rich in dietry fiber, micronutrients and phytochemicals. Research shows that sorghum and pearl millet grains are nutritionally comparable or even superior to major cereals such as wheat and rice owing to higher levels of protein with more balanced amino acid profile, dietary energy, vitamins, several minerals (especially micronutrients such as iron and zinc), insoluble dietary fiber leading to lower glycemic index.

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Sorghum is consumed in various forms around the world like baked bread, porridge, tortillas, couscous, gruel, steam-cooked products, alcoholic and non-alcoholic beverages etc. It has the potential to be processed into starch, flour, grits and flakes and used to produce a wide range of industrial products. It can also be malted and processed into malted foods, beverages and beer. On account of its nutritional significance, easy adaptability to a wide range of growing conditions, lesser water requirements, sorghum has the potential to be incorporated in the diets of human populations around the world, more specifically to those intolerant to wheat. In India, most of the sorghum produced is consumed in the form of 'roti' which is unleavened, flat bread (Sandhya and Waghray., 2018) [16].

Millets are known as 'Gods own crops' belongs to family *Gramineae*, are one of the oldest, small-sized cereal grains known to human from pre-historic time to be used as bird and animal feed. It has proved to have high nutritional as well as medicinal properties. Millets consist of slow-releasing carbohydrates and thus lowers the risk of diabetes. Also found to be rich in dietary fibres, minerals like iron, magnesium, phosphorous and potassium. Millets are gluten-free hence best suited for celiac patients (Thompson, 2009) [20]. India is the foremost producer of minor millets namely, Finger millet, Kodo millet, Barnyard millet, Pearl millet and Little Millet. Pearl millet (*Pennisetum glaucum* L.) *Bajra* is the fourth most important cereal of India after rice, wheat and sorghum. It is an important Kharif food crop of the arid and semi-arid crop in western India, Gujarat, Rajasthan and Haryana. It is considered as the wholesome cheapest food for poor people and animals. In India, 46% of Pearl millet used for human food use, 37.5% for animal feed, 7.7% for poultry feed, 8.8% for the brewing industry and a small amount (0.4%) is used for seed purposes. It is a good source of energy, protein, essential minerals and dietary fibre. The chemical analysis of Pearl millet showed that it contains moisture 12%, protein 12 g, fat 5 g, mineral 2 g, fibre 1 g, carbohydrate 67 g, calcium 42 mg, phosphorus 242 mg, iron 8 mg and accounts energy 360 calories. The values of nutritional composition are higher than rice and wheat. Besides these nutrients, they also have some phytochemicals with nutraceutical properties and hence are also termed as 'nutri-cereal'. There are some anti-nutritional factors also present in pearl millet limiting its bioavailability in the human gut but the digestibility can be improved by processing. The assimilation of Pearl millet to the convenience foods like cookies not only increases the nutritive value but also increase its production too. Replacement of whole-wheat flour with millet flour for health-conscious people is conceivably one more addition to the proliferating list of healthy foods. It is in need of time to include millets in the daily diet, hence there is a necessity to amplify the consumption of Pearl millet by incorporating it into food products like cookies (Kulkarni *et al*., 2021) [7].

Pearl millet (Bajra) is one of the oldest and healthy millet which was included in the regular diet by our ancestors. Now a days it is gaining its importance back. Pearl millet helps in increasing haemoglobin due to higher iron content among millets and also due to high zinc content. It also promotes bone growth and repair because pearl millet contains large amount of phosphorous content which is a key component for development of bones (Sachan and Shah, 2023) [15]. Cookies are one of the most widely consumed bakery products due to their convenience, longer shelf life, and sensory appeal. They are often considered an ideal vehicle for incorporating functional ingredients, as they can be easily fortified with cereals, pulses, and bioactive compounds without compromising consumer acceptability (Manley, 2011) [11]. In recent years, there has been a growing trend toward developing cookies with enhanced nutritional and functional properties to meet consumer demand for healthier snacks (Pareyt *et al*., 2009) [12]. Studies have shown that millet-based cookies exhibit higher nutritional value compared to conventional wheat cookies, though sensory acceptability may depend on the proportion of substitution (Rai *et al*., 2014) [13].

Legumes, on the other hand, are an excellent complement to cereals, as they are rich in protein, lysine, and micronutrients often lacking in cereals. Chickpea, green gram, and black gram flours are widely studied for improving the protein quality and overall nutritive value of baked products (Kadam *et al*., 2012) [8]. The combination of cereals and pulses is well-documented to provide a balanced amino acid profile, thereby improving protein quality and digestibility (Sangwan *et al*., 2014) [17].

In this context, the development of milletgram cookies, which blend millets with pulses, holds great promise. This combination can create a synergistic effect by improving both macro- and micronutrient profiles, while also enhancing functional properties such as glycemic control, satiety, and antioxidant activity (Srivastava *et al*., 2020) [18]. Such formulations can help address issues of malnutrition and lifestyle-related disorders, especially in developing countries where nutrient deficiencies are prevalent.

Consumer preference studies indicate that cookies enriched with millet and legume flours can achieve good acceptability if optimized properly in terms of texture, flavor, and color (Chaturvedi & Srivastava, 2008) [8]. The addition of legumes can sometimes impart a beany flavor, while higher levels of millet flour may affect spread ratio and crispness. However, with proper formulation techniques, it is possible to develop products that are both nutritious and organoleptically desirable (Sudha *et al*., 2007) [19].

Moreover, millet and legume-based cookies align with global trends in health-conscious eating, gluten-free diets, and the growing demand for plant-based functional foods. As consumers increasingly seek snacks that not only satisfy taste but also promote wellness, milletgram cookies present a unique opportunity to deliver both nutrition and health benefits in a familiar, convenient form (FAO, 2018).

Therefore, the formulation of milletgram cookies represents an innovative approach to developing sustainable, nutrient-dense bakery products. By leveraging the complementary nutritional benefits of millets and pulses, these cookies can serve as a functional snack option with potential applications in addressing malnutrition, promoting dietary diversity and supporting sustainable food systems (Kaur *et al*., 2019) [9]. Another important consideration in developing milletgram cookies is their potential application in gluten-free diets, especially for individuals with celiac disease. Celiac disease is an autoimmune disorder triggered by gluten ingestion in genetically predisposed individuals, leading to intestinal inflammation, malabsorption, and various health complications. The only effective treatment is lifelong adherence to a strict gluten-free diet, which poses challenges in terms of variety, accessibility, and nutritional adequacy (Ludvigsson *et al*., 2013) [10]. Since both millet

and gram are naturally gluten-free, their incorporation into cookies provides a safe, nutritious alternative for celiac patients while also catering to the growing market for gluten-free products.

Material and Methods

Materials

The raw ingredients, including sorghum flour, pearl millet flour, green gram dal flour, roasted bengal gram flour, jaggery powder, butter, cardamom powder, baking powder, milk, were procured from the local market. All the chemicals and glassware used in this research work were of analytical grade (AR) and were used from the laboratory in the Department of Food Process Technolgy. Equipment required in the present investigation was available at the College of Food Technology, Nashik. Procedures recommended by the Association of Official Analytical Chemists (AOAC, 1990) [1] were used for this research work.

Methodology

In a large mixing bowl, soften butter and jaggery powder were first creamed together until the mixture became light and fluffy. To this add sorghum flour, pearl millet flour, roasted Bengal gram flour, green gram dal flour, cardamom powder, baking powder. All the ingredients were mixed until mixed homogeneously. A measured quantity of milk was then added slowly just enough to bind all the ingredients into smooth and pliable dough. Once the dough was well formed, the cashew nuts were gently folded in until evenly distributed throughout the dough. The prepared dough was covered and allowed to rest for 15 minutes at room temperature to enhance binding and texture. After resting the dough was divided into small portion. Take each sized ball and gently flattened with the palm of the hand to shape them into cookies. The shaped cookies were placed on a greased baking tray, ensuring sufficient space between each cookie to avoid sticking. The oven was preheated to 175°C, and the cookies were baked for about 15-20 minutes until they were lightly golden brown and firm at the edges. Once baked, the cookies were removed from the oven and allowed to cool on the baking sheet for a 8-10 minutes before being transferred to a wire rack for complete cooling. The cooled cookies were then stored in airtight containers for further analysis.

Fig 1: Millet Gram Cookies

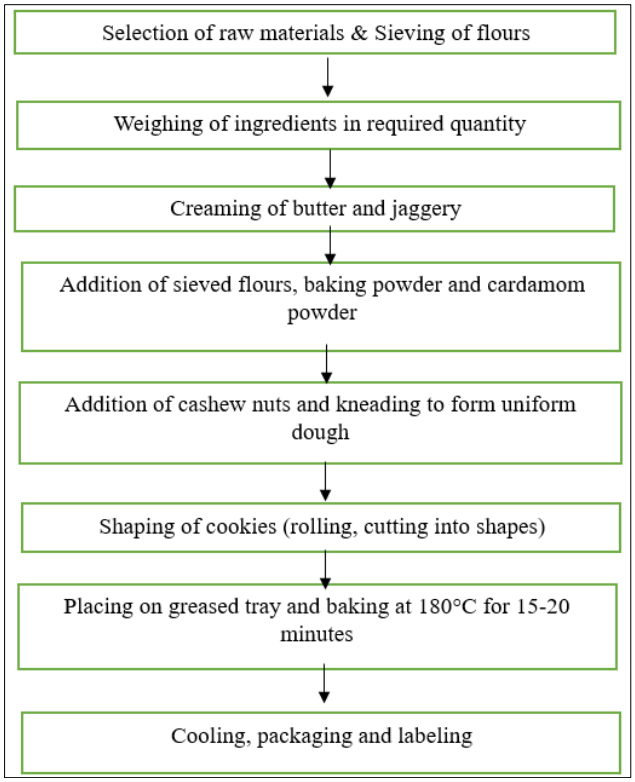

Fig 2: Process Flowsheet for Preparation of Cookies

Organoleptic Evaluation

Sensory quality of millet gram cookies was carried out by trained panel of ten judges on a 9 – point Hedonic scale (Amerine 1965) [1].

Determination of Chemical Characteristics of millet-gram Cookies

The chemical quality such as moisture content, protein, fat, ash and carbohydrate (by difference) were determined as per standard procedure by A.O.A.C., 1990., method.

The detailed procedures followed for these evaluations are described in the following section.

Moisture content

Moisture content was determined using the (A.O.A.C., 1990) [1] method. The following formula was used to measure the moisture content.

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

Ash content

Ash content was determined using the (A.O.A.C., 1990) method. A muffle furnace was used to determine the ash content of the samples. The per cent ash was calculated using the following formula.

Protein content

Protein content was determined using the (A.O.A.C., 1990) method. Kjeldahl apparatus was used to determine the crude protein content of samples. Micro- Kjeldahl steam distillation unit was used for distillation purposes. Per cent nitrogen and per cent protein was calculated by using the following formula.

$$\% \text{ Nitrogen} = \frac{\text{CBR} \times \text{N of acid} \times \text{Moles of nitrogen} \times \text{D.F.}}{\text{Weight of sample}} \times 100$$

Where,
CBR= Corrected Burette Reading Normality of Acid (H_2SO_4) = 0.01
Moles of Nitrogen = 0.014
D.F. = Dilution Factor
Total protein =% Nitrogen X Protein factor [6.25]

Fat content
Fat content was determined using the (A.O.A.C., 1990) method. Soxhlet apparatus was used to determine the crude fat content of samples.

$$\% \text{ Crude fat} = \frac{\text{Final weight flask} - \text{Empty weight of the flask}}{\text{Weight of sample}} \times 100$$

Crude fibre
The crude fibre content was determined using the (A.O.A.C., 1990) [1] method.

$$\% \text{ Crude fibre} = \frac{(W_2 - W_1) - (W_3 - W_1)}{W} \times 100$$

Total Carbohydrate
Carbohydrate was determined by difference method.

Result and Discussion

Standardization of Millet gram cookies

Table 1: The levels of millet flour replaced with wheat flour in the preparation of cookies.

Sr. No.	Ingredients	Control	T1	T2	T3
1	Refined wheat flour	100	00	00	00
2	Sorghum flour	00	21	20	22
3	Pearl millet flour	00	6	7	9
4	Moong dal flour	00	12	10	8
5	Roasted Bengal gram flour	00	8	10	8
6	Jaggery powder	--	22	22	22
7	Butter	25	22	22	22
8	Cardamom powder	2	2	2	2
9	Baking powder	2	2	2	2
9	Milk (ml)	5	5	5	5

Physical analysis
Physical analysis of cookies is an important step in understanding their overall quality and consumer acceptance.

Parameters such as diameter, thickness, weight, and spread ratio are generally evaluated to check the uniformity and texture of the baked product. These measurements help in comparing the performance of different formulations and also indicate how ingredients influence the final structure of cookies. For example, spread ratio gives an idea about the balance between cookie expansion and height, which is often linked with desirable crispiness and appearance. We used equipments such as vernier caliper, weighing balances for these tests, the data was obtained by taking average of three samples. These data provide meaningful insights into the products physical stability and market potential. Physical parameters and their values are mentioned in table given below.

Table 2: Physical Characteristics of Milletgram Cookies

Parameters	Selected (T1)
Diameter (mm)	50
Thickness (mm)	8
Weight (gm)	10
Spread Ratio	6.25
Color	Slightly darker golden brown
Shape	Round, smooth edges

Chemical analysis of Acceptable millet-gram cookies

Table 3: Proximate Composition of Milletgram Cookies

Parameters	Result(%)
Moisture content%	5.0 ± 0.058
Ash %	1.83 ± 0.167
Protein %	11.92 ± 0.33
Fat%	13.03 ± 0.08
Fiber %	3.83 ± 0.12
Carbohydrates %	64.39 ± 0.20

Sensory Evaluation: Sensory characteristics were evaluated using a 9-point Hedonic scale, where 9 represented "extremely liked" and 1 indicated "extremely disliked." The results, as shown in the figure, demonstrate that all treatments were assessed for overall acceptability. Among them, treatment T1 (21:6:12:8:22:22:2:2:5) achieved the highest mean score of 8.2, followed by T2, T3. The analysis indicated that T1 outperformed among all samples in overall acceptability. Furthermore, the T1 sample received high scores for individual attributes such as appearance, color, flavor, taste, texture and overall acceptability.

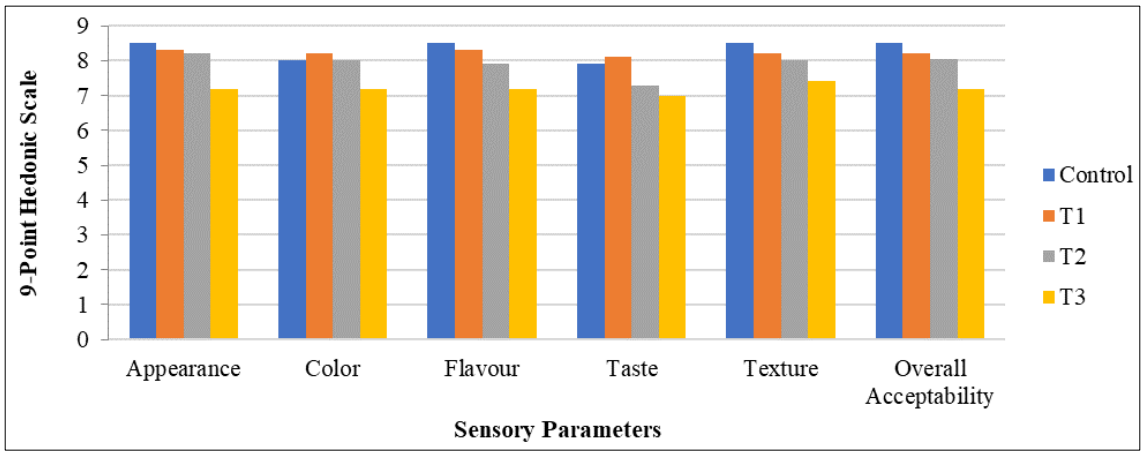

Fig 1: Sensory Evaluation of Milletgram Cookies

Conclusion

The present study highlights that millet-based formulations provide a rich nutritional profile and can serve as a promising base for the development of bakery products such as cookies. In this investigation, combinations of millets and legumes were used for the preparation of milletgram cookies, taking advantage of their protein quality, dietary fibre and mineral content. The findings demonstrate that the incorporation of millet blends not only enhanced the nutritional value of the cookies but also maintained desirable sensory attributes. Among the tested formulations, the treatment T1- consisting of sorghum flour, pearl millet flour, green gram dal flour, roasted Bengal gram flour, jaggery powder, butter, cardamom powder, baking powder, milk (21:6:12:8:22:22:2:2:5) with a balanced proportion of millet and gram flours recorded the highest acceptability in terms of taste, texture, and overall appeal. The good quality cookies can be prepared by incorporation of sorghum flour, pearl millet flour, green gram flour and roasted Bengal gram flour without affecting organoleptic quality. The standardized cookies contains 5.0 ± 0.058% moisture, 1.83 ± 0.167% ash, 11.92 ± 0.33% protein, 13.03 ± 0.08% fat, 3.83 ± 0.12% fiber and 64.39 ± 0.20% carbohydrates. Finally it can be concluded that the cookies fortified with millet and legume were found to contain high amount of proteins, minerals and sensory qualities were found acceptable. Milletgram cookies therefore represent a convenient, ready-to-eat product that delivers both health benefits, nutrition and consumer satisfaction. However, despite their potential, such nutritious alternatives are still underutilized in the commercial market. Continued research and development are needed to optimize formulations, improve shelf stability and promote wider adoption of millet-based bakery products for health-conscious consumers.

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