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RESEARCH ARTICLE

Development and Sensory Evaluation of Healthy Snacks for Youngsters Using Pearl Millet, Finger Millet and Sorghum

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Abstract

In the present scenario, millets are grabbing special attention among young masses and with the continuous promotional effort by the government and other organizations millets are becoming a crucial part in people'sdiet regimen. Millets have gained popularity due to their valuable nutritional properties and role in dietary management of different lifestyle chronic diseases. Traditional millet recipes have been prepared for many years, but the food industry is now introducing various experiments, novel approaches, creative ideas, and advanced processing techniques to make the preparation of these recipes easier and more convenient. To make millet recipes more popular among young students, an effort was made to develop some appealing, healthy, easy, and tasty snack recipes. The development process involved selecting three primary millets, namely, pearl millet (*bajra*), finger millet (*ragi*) and sorghum(*jowar*) as basic ingredients. These millets served as the foundation for developing various snack recipes like, pearl millet *nimki* (a savoury), fingermillet cookies and sorghum finger fries. These were then served to 30 college going students for sensory evaluation, using9-point hedonic scale for colour, texture, taste, flavour, and overall acceptability. The sensory evaluation of the developed snacks exhibited that finger millet cookies were liked very much by the students and received the highest mean score for overall acceptability (8.83±0.37), closely followed by pearl millet *nimki* (7.58±0.50), and sorghum finger fries (7.45± 0.50).The finger millet cookies also obtained highest scores for all the sensory attributes in comparison to the other two snacks. The nutritional value of the developed snacks per serving revealed pearl millet *nimki* (60 g/portion)to have highest content of carbohydrate (37.0 g), protein (7.0 g), and iron (3.8 mg), while finger millet cookie (40 g/portion) was found to be rich in calcium (223.0 mg). Sorghum finger fries (60 g/portion), as a fried snack, contributed significant calories (286.6 kcal).

Keywords: Millets, Finger millet, Pearl millet, Sorghum, Sensory evaluation

Introduction

Millets are recognized as nutri-cereals because they provide a plentiful supply of macro and micronutrients, as well as phytochemicals. They are also specified as “yesterday's coarse grains and today's nutri-cereals” (Gowda *et al*., 2022). They are abundant in nutrients compared to many staple cereals such as rice, wheat, and maize, offering higher levels of proteins, fiber, vitamins, and minerals. Additionally, they are gluten-free, earning them the title of "superfoods" (Ashoka *et al*., 2020). These nutrient rich millets play crucial role in combating food insecurity and malnutrition.

Major millets encompass pearl millet, finger millet, and sorghum, while minor millets consist foxtail millet, kodo millet, proso millet, small millet, and barnyard millet (Fig. 1). Since old times, millet has been ingested frequently in both Asia and India (Garg *et al*., 2022).

At the industry level, various processing techniques are employed to make these remarkable crops readily available to the public (Dayakar Rao and Nune, 2021). Processing also impacts the nutritional content and digestibility of millets simultaneously (Gowda *et al*., 2022). Additionally, they enhance the shelf life and retain the nutritive value and sensory properties of the food products (Deshpande *et al*., 2021). In different food industries primary processing ways similar as, dehulling, germination, soaking, drying, polishing and milling are used whereas ultramodern or secondary processing procedures as, turmoil, malting, parboiling, puffing, popping, cooking, incinerating, unloading, extrusion, etc., are also being incorporated to prepare value- added millet food products (Bunkar *et al*., 2021).

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Source: Dayakar Rao and Nune, 2021

Fig. 1. Different types of Millets

Nutrient Composition of Millets

The edible millet kernel encompasses 2-7% crude fiber,65% carbohydrate, 9% protein, 3% fat and 0.2-0.3% polyphenols. They are also prime source of micro-nutrients like iron, calcium, magnesium, manganese, phosphorus, and antioxidants. Millets serve as a robust source of essential amino acids, except for amino acids such as lysine and threonine. They are also enriched with sulfur-containing amino acids like methionine and cysteine (Eduru *et al*., 2021).There are also some important fatty acids like, linoleic acid, oleic acid, and palmitic acid that are found both in free and bound forms. Millets have vitamin B compounds such as niacin, folacin, riboflavin, and thiamine, that play major role in the creation of energy (Sarita and Singh, 2016). There are further more 50 phenolic composites in different classes of millets found, including phenolic acids and their derivations as flavan-3-ol monomers and dimers, flavones, flavanols, and flavanonols.

Pearl millet has high starch content in form of amylase (20–22%), and insoluble dietary fiber ratioproducinga lower glycemic response (Shobana *et al*., 2018). It has gluten-free protein to withstand gluten sensitivity or celiac disease in people. Finger millet is a rich source of carbohydrate among the selected millets. Due to resistant starch, dietary fiber and slowly soluble carbohydrates, it represents low glycemic index compared to most common cereals such as rice and wheat (Neeharika *et al*., 2020). Finger millet scores a good amino acid and contains threonine, lysine, and valine than other millets also micronutrients as calcium, iron, magnesium, potassium, and zinc, as well as, B- vitamins, especially niacin, B6, and folic acid, are considerably present in the millet. Sorghum millets are rich source of antioxidants in the form of different vitamins, minerals fatty acids and fibers that controls various chronic disorders like cardiac, diabetes, tumor growth or immunity etc. The millet contains carbohydrates, dietary fibre, proteins, fat out of which different types of fats such as saturated, monounsaturated, polyunsaturated, omega-3 fatty acids and omega-6 fatty acids are abundantly found and it is also having zero cholesterol. Besides major nutrients the millet is rich source of vitamin B1, vitamin B2, vitamin B3, vitamin B5 or pantothenic acid, vitamin B6, vitamin B9 or folate, vitamin E or alpha tocopherol, calcium, magnesium, potassium, zinc, copper, and selenium.

Anti Nutrient content of Millets

One of the disadvantages of millets is their high content of anti-nutritional factors as compared to staple cereals like wheat and rice. The anti-nutritional factors present in millets affect nutrient absorption, with the effect of reduced nutrient bioavailability and further utilization (Bora *et al*., 2019).When millets are consumed without proper processing or heat treatment, they create health issues, such as micronutrient malnutrition, other nutritional deficiencies, and bloating. The anti-nutrients present are tannins, oxalates, trypsin, phytates and chymotrypsin inhibitors (Popova and Mihaylova, 2019). Elimination of anti-nutrient components, the millets need pretreatment or processing of grains, such as de-branning, soaking, germination, fermentation, and autoclaving (Lokesh *et al.,* 2022). These methods enhance the bioavailability of certain minerals like, iron, calcium, and zinc, as well as, protein absorption (Birania *et al*., 2020).

Processing of Millets

Processing is normally implemented for enhancing the quality of grains and for reducing the anti-nutrientcontent (Rathore *et al*., 2019). Several forms such as, milled flour, salted ready-to-eat grains, porridges, and processed form, such as, popped, roasted, sprouted and fermented foods convert millets in more consumable form (Downs *et.al*., 2022). Fermentation of millets not only enhances the taste but also enriches the food with fiber, calcium and protein and reduces anti-nutrient content (Hema *et al*., 2022). Germination and fermentation methods support the overall nutritional importance of millets, whereas extreme dehulling, polishing, and milling lowers the dietary fiber and micronutrients (Yousaf *et al*., 2021).

Health Benefits of Millets

Millets contribute in many nutritional, nutraceutical, and health and wellness industries particularly, because of its high fiber and micronutrient content (Ambati and Sucharitha, 2019). All millets represent high antioxidant properties due to presence of phyto-chemicals (Mounika *et al.,* 2022). These wonder nutria cereals prevent various degenerative diseases and maintain the gut health (Kaur *et al*., 2019).These are gluten free and non-allergenic to celiac problem(Devi and Rajendran, 2021). Some of the health benefits of millets are -

- Non-starchy carbohydrates and dietary fiber content of millets, help in preventing constipation and in lowering blood cholesterol level.
- Blood triglyceride and C-reactive protein levels are managed, which help in preventing cardio-vascular diseases.
- Millet intake results in reduced glycemic load due to gradual absorption of glucose after digestion (Geetha *et al*., 2020).
- By acting as a pre-biotic source, millets maintain the health of the microflora in human gut thus reducing the cases of duodenal ulcers, and cardiovascular illnesses (Mishra *et al.,* 2022).
- Millet contains a lot of tryptophan, which synthesizes neuro-transmitter serotonin.
- Pearl millet containing insoluble dietary fiber shows lower glycemic response (Shobana *et al*., 2018) and due to gluten-free protein, it is good for patients with celiac disease.
- Finger millet too have resistant starch, dietary fiber and slowly soluble carbohydrates showing low glycemic index (Sewak *et al*., 2023), also the millet is with loads of micronutrients and essential amino acids.
- Sorghum millet have many beneficial effects in cardiac, diabetic and tumor cases due to presence of micronutrients, essential fatty acids and amino acids.

Materials and Methods

For the study 30young college students between 18 and 22 years, residing in urban area, were selected. The students were asked to fill consent forms before participating in the study. In all three different recipes of millets, snacks were developed, using simple, traditional, and household processing techniques. The three recipes developed were-**pearl millet(*bajra*) *nimki*, finger millet (*ragi*) cookies, and sorghum (*jowar*) finger fries.** The developed recipes were organoleptically evaluated by the students, using 9-point hedonic scale for various sensory attributes. Selection of students was

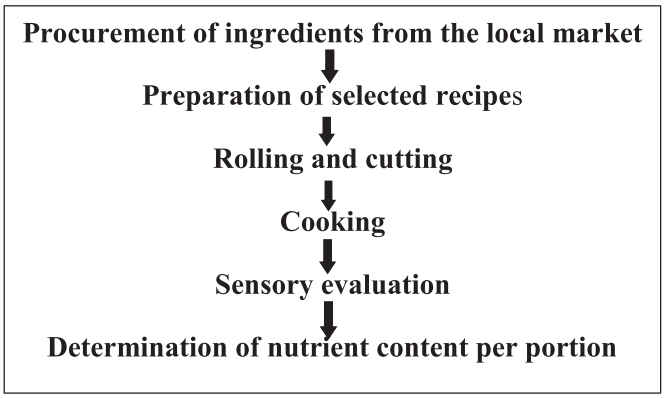

Fig. 2. Different steps followed in development of recipes

based on the sensitivity threshold test.

The steps followed for preparation and evaluation of the recipes were (Fig. 2):

Procurement of the ingredients - The millets and other ingredients. The millets were procured in the powdered form.

Procurement and Development of the recipes – The raw materials selected for the development of recipes were procured from the local market, millet flours were already in the processed form (milled), following which standardization of recipes was carried out in the Food Science laboratory for the quantity of ingredients, cooking method and yield. Determination of portion size of each of the snack recipe was based on provision of at least $1/6^{th}$ of the calorie requirement of college going girl.

Sensory evaluation–The final recipes were then served separately to the college students for organoleptic evaluation, using 9-point hedonic scale, for their colour, texture, flavour, taste and overall acceptability (Fig. 3). Students selected for the evaluation were tested before for sensitivity threshold.

Nutrient content - The nutrient content of the developed recipes was calculated per portion, using IFCT tables given by Longvah *et al*. (2017).

Results and Discussion

The results of sensory evaluation of the developed millet snacks revealed highest overall acceptability score for finger millet cookies (8.83±0.37), followed by pearl millet *nimki* (7.58±0.50), and sorghum finger fries (7.45±0.50). Finger millet cookies also scored highest for other sensory attributes *viz*. colour, texture, flavour and taste in comparison to the other two products (Table 1). When evaluating sorghum finger fries and pearl millet *nimki*, it was observed that sorghum finger fries outperformed in sensory attributes such as colour, texture, and flavour. However, it received a comparatively lower score in terms of taste.

The nutritional value of the developed snacks was calculated per portion, using IFCT tables given by Longvah *et al*. (2017). It revealed pearl millet *nimki* of one portion that is 60 g contains highest amount of carbohydrate (37.0 g), protein (7.0 g), and iron (3.8 mg) per serving, while one portion of finger millet cookies (40 g/ portion)was found to provide highest amount of calcium (223.0 mg), followed by (one portion that is 60 g) of sorghum finger fries (21.8 mg) and pearl millet *nimki* (16.2 mg). Sorghum finger fries, as a fried snack, contributed significant calories (286.6 kcal) per serving in comparison to the other two snacks (Table 2).

Table 1. Mean sensory scores of the developed snacks from millets

Developed snacks	Colour	Texture	Flavour	Taste	Overall acceptability
Pearl millet (*Bajra*) *nimki*	7.45 ±0.67	7.0 ±0.77	7.45 ±0.50	8.32 ±0.59	7.58 ±0.50
Finger millet (*Ragi*) cookies	8.74 ±0.44	8.70 ±0.46	8.70 ±0.46	8.77 ±0.42	8.83 ±0.37
Sorghum (*Jowar*) finger fries	7.64 ±0.48	7.51 ±0.50	7.77 ±0.42	6.54 ±0.50	7.45 ±0.50

Fig. 3. Developed Snacks from Millets

Table 2. Nutritional value of the developed snacks from millets.

Developed snacks	Amount per portion (g)	Energy (kcal)	Carbohydrates (g)	Protein (g)	Calcium (mg)	Iron (mg)
Pearl millet (*Bajra*) *nimki*	60	248.6	37.0	7.0	16.2	3.8
Finger millet (*Ragi*) cookies	40	175.4	30.6	0.28	223.0	2.4
Sorghum(*Jowar*) finger fries	60	286.6	26.8	6.4	21.8	2.3

Conclusion

In conclusion, snacks made from the three millets present a promising avenue for promoting healthier dietary habits among youngsters. These snacks offer a diverse range of options, from cookies to *nimki* and finger fries, each boasting superior nutritional profiles. By prioritizing sensory appeal and convenience, millet-based snacks can easily integrate into the busy lifestyles of today's youth, providing satisfying and nutritious alternatives to traditional snacks.

Conflict of Interest

The Authors declare no conflict of interest.

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