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Studies on physicochemical properties of barnyard millet (*Echinochloa esculenta* L.) and little millet (*Panicum sumatrense* L.)

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Abstract

The present study was carried out for the development of a nutritional dosa premix by incorporating barnyard millet and little millet. The investigation encompasses a thorough analysis, including sensory acceptability, proximate and mineral composition, and a study on storage and packaging materials. The physical attributes of barnyard millet, such as shape, length, width, and thickness, were measured, revealing specific dimensions and characteristics. Proximate composition analysis of barnyard millet and little millet included parameters like moisture, ash, protein, carbohydrate, fibre, and fat, demonstrating variations between the two components. The mineral composition unveiled distinct concentrations of essential elements in barnyard millet and little millet, such as phosphorus, iron, calcium, zinc.

Keywords: Barnyard millet, little millet, celiac disease, dosa premix, rice replacement, disease prevention

Introduction

Millets are widely grown around the world as major grains for provender and human food in the olden days. Millet is a collective term referring to a number of small-seeded annual grasses that are cultivated as grain crops, primarily on marginal lands in dry areas in temperate, subtropical and tropical regions. It is belonging to the grain family which has been classified into many varieties in ancient periods. The other states like Tamil Nadu, Madhya Pradesh, Andhra Pradesh, Karnataka, Maharashtra, and Orissa also contribute their major share in the total millet production of India. Minor millets are claimed to be future foods for better health and nutrition security in the recent years, they are recognized as important substitutes for major cereal crops to cope up with the world food shortage and to meet the demands of increasing population (Roopa *et al.*, 2017) [20].

Now a days, the main risk factors for the high prevalence of diabetes among Asian - Indians were high racial susceptibility to diabetes, central obesity, insulin resistance and lifestyle changes due to the urbanization. To fight type 2 diabetes and its high risk of cardio vascular disease, life style intervention with diet and exercise are of utmost importance. Barnyard millet is recommended to patient who suffer from cardiovascular diseases and diabetes. They are also most effective to reduce the blood glucose level and lipid level. The barnyard millet ideal millet for those patients who have gluten intolerance which cause celiac disease (Kaur *et al.*, 2020) [9]. From the nutritional aspect, barnyard millet is a fair source of highly digestible protein, lipid, vitamins B1 and B2 and nicotinic acid compared with other cereals, such as rice and wheat grains. However, barnyard millet shows the highest concentration of iron (40.2 ppm) followed by finger millet (34.15 ppm) (Karakanavar *et al.*, 2021) [8].

Barnyard millet is a fastest growing crop as compared to other millets. It is a multipurpose crop, thrives well even under adverse agro climatic conditions. Barnyard millet is main crop (among millet) of North Western Himalayan Region (NWHR) of India, and is popularly known as Jhingura. It is also known as 'sawa' millet. In India, its cultivation is restricted to hilly and semi-arid regions of Southern peninsula of Tamil Nadu, Andhra Pradesh, Karnataka and Northern states of Jharkhand and Uttar Pradesh (Veena *et al.*, 2010) [30].

Barnyard millet is short duration crop that can grow in adverse environmental conditions with almost no input and can withstand various biotic and abiotic stresses. In addition to these agronomic advantages, the grains are valued for their high nutritional value and lower expense as compared to major cereals like rice, wheat, and maize. In terms of nutritive value, barnyard millet is superior to major and minor millets. Barnyard millet flour is also highly compatible to blend with other food flours for making novel or any value-added products without affecting the flavour and taste (Renganathan *et al.*, 2020) ^[18].

The grains of barnyard millet are used as food and can be consumed by cooking like rice and also can be used as functional food for people suffering from allergic diseases and atopic dermatitis. In addition to this, since the grain contains almost no gluten therefore it is one of the most suited millets for the ones suffering from celiac disease, in which patients are intolerant to gluten. Indian based Barnyard millet is grown up to 2300 from the mean sea level (MSL) predominantly in kharif season in the elevation of Uttarakhand and Tamil Nadu states (Gomashe *et al.*, 2017) ^[5]. Barnyard millet is a superior grain with decent levels of dietary fibre and macronutrients. It is an essential grain with good cooking and sensory characteristics. Low in terms of calories. Barnyard millet is a good source of highly digestible protein and relative to all other cereals, is at the same time less dense in calories. Barnyard millet grains are a rich source of dietary fibre, iron, zinc, calcium, protein, magnesium, fat, vitamins and some essential amino acids. The iron content in barnyard millet grain is about 15.6–18.6 mg/100 g, which is rationally higher than major cereals and millets. Barnyard millet contains carbohydrates (65%), proteins (11%), fat (3.9%) and crude fibre (13.6%) (Shinde *et al.*, 2021) ^[22].

Little millet (*Panicum sumatrense*) is an important underutilized grain, also called as Savi, Kutaki, Sama, Sam, Savai, Samai, Chama etc. The average yield of little millet is around 0.5-1 tones/ ha. It is rich in minerals such as iron. Additionally, it can blend with most of traditional and novel foods without imparting any flavour of its own. Dietary fibre content of little millet is the contributing factor for its low glycaemic index and a recent study conducted on little millet indicated that it exhibits hypoglycaemic effect due to its higher proportion of dietary fibre (Itagi *et al.*, 2012) ^[15]. It has a significant role in providing significant amounts of antioxidants and phytochemicals in the diet (Ushakumari and Malleshi 2007) ^[29]. The diversification of diet with little millet-based products would help to achieve food and nutritional security effectively and economically. Little millet (Samai) grains are harvested in large amounts at Coimbatore, Namakkal district, and the hilly region of Tamil Nadu state. It is one of the major foods for tribal daily consumption. Little Millet (samai) plays a major role in the Indian diet. It was an excellent source of nutraceuticals and micro-nutrients which gives medicinal beneficial properties. Little millet (*Panicum sumatrense*), is a minor cereal and it is recognized for several health benefits due to the presence of bio-active nutraceutical. It was a good source of phosphorus and the presence of fibre helps to lower the fat level in the body. The anti-oxidant and low-calorie content which is present in the samai, helps to maintain a balanced diet and weight that can promote weight loss (Indirani *et al.*, 2021) ^[6].

Little millet is one of the hardiest millets, which thrives well under adverse agro-climatic conditions. Nutritionally little millet is a superior grain with good amounts of macronutrients and dietary fibre. Processing little millet into flakes will not only add convenience while cooking but also indicated potential benefits of medium glycemic index and it does not contain trans fats and have good shelf life. Hence it could be worthy addition to one's diet as healthy food. However, there is scope to explore the potential benefits of little millet flakes in the management of metabolic disorders through long term feeding intervention. Little millet is nutritious and has a significant role in providing nutraceutical components such as phenols, tannins and phytates along with macro and micro-nutrients. It is a fair source of protein (7.70 to 16.50%), fat (2.45 to 9.04%), carbohydrates (62.50 to 76.30%), an excellent source of dietary fibre (15.90 to 18.10%) contains good amount of soluble (3.15 to 5.70%) and insoluble fractions (10.20 to 14.95%) (Patil *et al.*, 2014) ^[15].

Materials and Methods

The present study was carried out to prepare instant dosa premix incorporated with barnyard millet and little millet. The acceptability, nutritional composition and storage study of prepared dosa premix incorporated with barnyard millet and little millet were evaluated.

Materials

Raw materials such as barnyard millet, little millet, rice and black gram was sourced from the local market in Parbhani, while chemicals and reagents was acquired from the laboratory at the Department of Food Science and Nutrition, College of Community Science and Department of Food Chemistry and Nutrition, College of Food Technology, VNMKV, Parbhani (MS).

Chemicals and glassware

Chemicals of analytical grade and sufficient glassware required were available in the laboratory, Department of Food Science and Nutrition, College of Community Science and Department of Food Chemistry and Nutrition, College of Food Technology, VNMKV, Parbhani (MS).

Equipment

The equipment and machinery needed such as a weighing balance, hot air oven, vernier calliper, spectrophotometer, Micro-Kjeldahl, Soxhlet apparatus, atomic absorption spectrophotometer and muffle furnace were utilized for the current investigation and were provided by the Department of Food Science and Nutrition at the College of Community Science and Department of Food Chemistry and Nutrition, College of Food Technology, VNMKV, Parbhani (MS).

Packaging material

The packaging materials, including aluminum foil, HDPE used for packaging the final product, were procured from the Parbhani market.

Methods

Physical properties of Millet

3Weight

The average weight of 1000 barnyard millet and little millet was determined using electronic weighing balance.

Length, width and thickness

A vernier calliper was used to measure the axial dimensions of randomly selected barnyard millet and little millet for length, width and length.

Shape

The shape of barnyard millet and little millet was determined visually.

Colour

The Colour of barnyard and little millet was inspected visually.

Proximate composition of barnyard millet and little millet

Barnyard and little millet were analyzed for proximate composition, including moisture, fat, protein, total carbohydrate, crude fibre, ash and mineral composition as per the methods given by (AOAC, 2005) [3].

Result and Discussion

Physical characteristics of barnyard millet and little millet

Physical properties of barnyard millet and little millet such as shape, length, width, thickness, weight of 1000 seeds were determined to ensure uniformity and consistency of final product, designing equipment, processes to handle the materials effectively, to optimize the manufacturing process, help to efficient mixing, preventing issue like uneven mixing of ingredients.

Data pertaining to physical properties such as shape, color, length, width, thickness, weight of 1000 seed were analyzed and depicted Table 1.

Table 1: Physical characteristics of Barnyard millet and little millet

Physical parameter	Barnyard millet	Little millet
Shape	Oval	Oval
Color	Dull cream	Dull whitish
Length (mm)	3.245±0.14	3.054±0.24
Width (mm)	1.824±0.02	1.87±0.09
Thickness (mm)	1.162±0.07	1.389±0.08
1000 kernel weight (g)	3.179±0.03	3.087±0.07

*Each value is a mean of three determination

Data from the table 1 reveal that the shape of barnyard millet was found to be oval or concave in shape. Shape of little millet evaluated visually appeared as elliptical. Dimensional parameters such as length, width and thickness were measured using digital caliper. The dimensional properties of barnyard millet such as length, width and thickness were noted to be 3.245±0.14 mm, 1.824±0.02 mm, 1.162±0.07 mm and physical properties of little millet i.e., length, width, thickness, were reported to be in the range of 3.054±0.24 mm, 1.87±0.09 mm, 1.389±0.08 mm. Rao *et al.*, (2020) [16] reported similar finding for physical parameters. Color of barnyard millet was found to be dull cream whereas, little millet appeared dull whitish in color. The reading for 1000 kernel were taken and noted as for barnyard millet and little millet 3.179±0.03 g, 3.087±0.07 g respectively. Similar observations have been noted by Reddy *et al.*, (2019) [17], Biradar *et al.*, (2020) [4], Revathi *et al.*, (2016) [19].

Proximate composition of barnyard millet, little millet

The study investigates nutritional components of raw material such as moisture, protein, fat, carbohydrate, ash and crude fiber, expresses in percentage and is depicted in Table 2

Table 2: Proximate composition of Barnyard millet and little millet

Chemical properties (%)	Barnyard millet	Little millet
Moisture	12.35 ± 0.23	11.53 ± 0.45
Ash	4.21 ± 0.34	1.26 ± 0.15
Protein	10.98 ± 0.77	10.25 ± 0.65
Carbohydrate	55.54 ± 1.03	65.32 ± 2.14
Fibre	13.6 ± 1.24	7.72 ± 0.59
Fat	3.32 ± 0.21	3.92 ± 0.51

*Each value is a mean of three determinations

The tabulated data above deals with the proximate composition of barnyard millet and little millet which are major ingredients used for product development. Barnyard composition can be influenced by genetics, climate, seed processing as well as evaluation method. The Table 2 reveals the moisture content, ash, protein, carbohydrate, fiber and fat in barnyard millet to be 12.35 percent, 4.21 percent, 10.98 percent, 55.54 percent, 13.6 percent and 3.32 percent. The similar values in accordance to present study were reported by Nazni *et al.*, (2016) [17].

Tabulated results reveal the proximate composition of little millet. It was evident from table that moisture content was 11.53 percent whereas crude fat content was 3.92 percent. The average value of total protein, ash and crude fiber of little millet was found to be 10.25, 1.26 and 7.72 percent respectively. Furthermore, total carbohydrates content of little millet was reported 65.32 percent. Obtained results for proximate composition of little millet were found to be in close agreement with the result reported by Biradar *et al.*, (2020) [4] and Indirani (2021) [6]. Barnyard millet and little millet can add nutritional benefits to dosa premix.

Mineral composition of barnyard millet and little millet

The determination of minerals content of raw materials i.e. barnyard millet and little millet is essential to know the bio-availability of micro-nutrients to the body. Data pertaining to mineral composition demonstrated in Table 3

Table 3: Mineral composition of barnyard millet and little millet

Minerals (mg/100 g)	Barnyard millet	Little millet
Calcium (Ca)	23.31±2.14	16.17±1.36
Phosphorus (P)	282±2.65	221±1.26
Iron (Fe)	5.05±1.58	1.42±0.29
Zinc (Zn)	2.14±1.98	3.67±2.87

*Each value is a mean of three determinations

The above tabulated data reveals the mineral content in different raw material samples i.e., barnyard millet and little millet. The barnyard millet was noted to have remarkable mineral content as phosphorus 282 mg/100 g, calcium 23.31 mg/100 g, iron 5.05 mg/100 g and Zinc 2.14 mg/100 g. The study showed that barnyard millet was good sources phosphorus, calcium, iron and zinc. The close readings were reported by Biradar (2020) [4], Karakannavar (2021) [8] and Kaur (2020) [9].

The mineral content of little millet was evaluated and found that the phosphorus content of little millet found to be

highest (221 mg/100 g) than the rest of other minerals. From the results obtained it was clearly seen that little millet is potent source of calcium (16.17 mg/100 g). Moreover, zinc content was 3.67 mg/100 g and iron was 1.42 mg/100 g. The study showed that the little millet was good sources of calcium, iron phosphorus and zinc. The similar findings were mentioned by Patil (2014)^[15].

Conclusion

The physical attributes of barnyard millet and little millet was carried out and the physical parameters of barnyard millet with respect to length, width and thickness were noted to be 3.245±0.14 mm, 1.824±0.02 mm, 1.162±0.07 mm respectively. Similar findings for the physical properties of little millet i.e., length, width, thickness, were reported to be in the range of 3.054±0.24 mm, 1.87±0.09 mm, 1.389±0.08 mm. Color of barnyard millet was found to be dull cream whereas, little millet appeared dull whitish in color. The reading for 1000 kernel were taken and noted as for barnyard millet and little millet 3.179±0.03 g, 3.087±0.07 respectively.

The proximate composition of barnyard millet and little millet was evaluated moisture content, ash, protein, carbohydrate, fiber and fat in barnyard millet to be 12.35 percent, 4.21 percent, 10.98 percent, 55.54 percent, 13.6 percent, and 3.32 percent. Proximate composition of little millet revealed were moisture content was 11.53 percent whereas crude fat content was 3.92 percent. The average value of total protein, ash and crude fiber of little millet was found to be 10.25, 1.26 and 7.72 percent respectively.

Mineral composition of barnyard millet and little millet was carried out where, the barnyard millet was noted to have remarkable mineral content as phosphorus 282 mg/100 g, calcium 23.31 mg/100 g, iron 5.05 mg/100 g and Zinc 2.14 mg/100 g. The mineral content of little millet was evaluated and found that the phosphorus content of little millet found to be highest (221 mg/100 g) than the rest of other minerals. little millet is potent source of calcium (16.17 mg/100 g). Moreover, zinc content was 3.67 mg/100 g and iron was 1.42 mg/100 g.

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