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Formulation and Quality Assessment of Little Millet-Moringa Fortified Dosa Premix

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Abstract
Background: *The development of functional foods increasingly focuses on nutrient-dense products prepared from millets and plant bioactives. Little millet is rich in dietary fibre and minerals, while moringa leaves provide protein, iron, calcium, and antioxidants.* **Objective:** *This study aimed to formulate and evaluate a little millet–moringa fortified dosa premix with respect to nutritional quality, sensory acceptability, and functional characteristics.* **Materials and Methods:** *This study formulated the dosa premix using carefully standardised proportions of little millet flour, urad dal, chana dal, fenugreek seeds, and moringa leaf powder. Three formulations with varying levels of moringa were developed. Sensory attributes were evaluated using a 5-point hedonic scale. Nutritional composition and phytochemical properties were analysed using standard analytical methods.* **Results:** *The optimised formulation exhibited the highest sensory scores for colour, texture, taste, and overall acceptability. Nutritional analysis showed higher carbohydrate (76.7%), fat (11.2%), energy (411.68 kcal/100 g), and iron content (3.66 mg/100 g). Phytochemical screening confirmed the presence of flavonoids and saponins, indicating antioxidant potential.* **Conclusion:** *The developed little millet–moringa dosa premix is nutritionally enriched, sensory acceptable, and convenient. The product may support dietary diversification and improved micronutrient intake.*
Keywords: Little Millet, Moringa Oleifera, Dosa Premix, Functional Food, Nutritional Quality, Sensory Evaluation

Introduction

Millets are among the earliest domesticated cereal crops, with evidence of cultivation dating back more than 5,000 years in Asia and Africa (Reddy et al., 2017). Millets are considered nutri-cereals because of their superior nutritional profile compared with widely consumed cereals such as rice and wheat (Devi et al., 2014). Millets contribute significantly to dietary diversification, food security, and sustainable agriculture, particularly in semi-arid and marginal environments (Anitha et al., 2021).

In India, the Green Revolution led to a gradual shift from traditional millet-based diets toward rice and wheat, resulting in reduced millet consumption over the past several decades (Subramanian & Viswanathan, 2019). The rising prevalence of lifestyle-related disorders, including obesity, diabetes mellitus, and cardiovascular diseases, has renewed interest in millet-based foods due to their low glycaemic index and high dietary fibre content (Chandra et al., 2016). To highlight the nutritional and agronomic significance of millets, the Food and Agriculture Organization (FAO, 2023) designated 2023 as the International Year of Millets and encouraged their global production and consumption.

Little millet (Panicum sumatrense) is a climate-resilient cereal crop. It matures within a short span and requires minimal water and agricultural inputs (Muthamilarasan & Prasad, 2021). Nutritionally, it is a rich source of complex carbohydrates, protein, dietary fibre, and essential minerals such as iron (Nirmala & Subba Rao, 2016). Its low glycaemic index makes it particularly suitable for individuals with diabetes and for weight management diets (Shobana et al., 2013).

With increasing urbanisation and time constraints, there is a growing demand for convenient, ready-to-use food products that retain traditional food value (Srilakshmi, 2018). Dosa, a widely consumed fermented cereal-based food, can be adapted into a ready-to-use premix to meet modern dietary needs. Nutritional value can be further improved by fortifying these products with nutrient-rich ingredients.

Moringa oleifera leaves serve as a nutrient-dense functional ingredient and provide high-quality protein, calcium, iron, vitamins, and antioxidant compounds (Mbikay, 2012). Incorporating moringa leaf powder into cereal-based products improves micronutrient density and functional quality, thereby helping to reduce deficiencies such as iron-deficiency anaemia (Anitha et al., 2021). Therefore, this study focused on formulating and evaluating a little millet–based dosa premix fortified with moringa leaf powder by assessing its sensory acceptability, nutritional composition, flowability, and phytochemical profile to develop a nutritionally enriched and consumer-acceptable functional food product.

Materials and Methods

Procurement of Raw Materials

The raw ingredients, including little millet grains, dehusked urad dal, chana dal, fenugreek seeds, and fresh moringa leaves, were procured from local markets. All grains and seeds are cleaned to remove dirt and impurities. The cleaned little millet, urad dal, and chana dal were stored in airtight containers at room temperature, while fenugreek seeds were stored in a cool, dry environment. Fresh moringa leaves were refrigerated until further processing.

Pre-processing of Raw Materials

Each ingredient underwent pre-processing to enhance flavour and shelf life. Little millet, urad dal, chana dal, and fenugreek seeds were separately dry-roasted over low heat until they emitted a nutty aroma and turned slightly golden. After cooling to room temperature, each roasted material was milled to obtain a fine powder. Fresh moringa leaves were washed, spread on trays, and dehydrated in an oven at 80°C for approximately 2 hours. The dried leaves were then ground into a fine moringa powder.

Formulation of Dosa Premix

Dosa premix variants were prepared by mixing the component flours in fixed proportions. The base formulation consists of 50 g of little millet flour, 50 g of urad dal flour, 15 g of chana dal flour, and 4 g of fenugreek flour. Three variants were prepared by incorporating different amounts of moringa powder: 1 g (V1), 2 g (V2), or 3 g (V3) per 100 g total premix. Measured quantities of each ingredient are thoroughly blended to ensure uniform distribution. The final premix provides balanced nutrition, rich in protein, fibre, vitamins, and minerals, making it suitable for instant dosa preparation.

Nutrient and Phytochemical Analysis

The proximate composition of the formulated premix was evaluated using standard methods. Moisture and ash contents were determined gravimetrically (IS 3077), fat by solvent extraction (AOAC 950.4), and protein by the Kjeldahl method (IS 7219). Carbohydrate content was estimated by difference, and energy value was calculated from macronutrient composition. Iron content was measured using atomic absorption spectroscopy. Phytochemical screening was conducted to detect bioactive compounds such as flavonoids, saponins, alkaloids, and tannins using conventional qualitative assays.

Results and Discussion

Sensory Evaluation of Dosa Premix

A trained panel evaluated the sensory attributes of each premix variant using a nine-point hedonic scale. Attributes included colour, consistency, taste, texture, and overall acceptability. As shown in Table 1, Variant 2 (with 2 g moringa) achieved the highest scores for most attributes. For example, V2 scored 4.5 ± 0.6 for colour and 5.0 ± 0.0 for overall acceptability. In comparison, V1 recorded scores of 4.2 ± 0.7 and 3.7 ± 0.7, while V3 obtained 4.1 ± 0.8 and 3.8 ± 0.7 for colour and overall acceptability, respectively. The improved scores indicate that the 2% moringa formulation had the most favourable sensory profile. In contrast, the lower (1 g) and higher (3 g) level of moringa resulted in slightly lower acceptance. In summary, the intermediate moringa level yielded the most acceptable product, while small deviations in formulation had noticeable effects on sensory quality.

Table 1 Sensory Evaluation of the Developed Dosa Premix (Mean ± SD)

Attribute	V1 (1 g Moringa)	V2 (2 g Moringa)	V3 (3 g Moringa)
Colour	4.2 ± 0.69	4.5 ± 0.60	4.1 ± 0.75
Consistency	4.1 ± 0.71	4.2 ± 0.80	3.9 ± 0.80
Taste	4.03 ± 0.76	4.2 ± 0.80	4.1 ± 0.80
Texture	3.8 ± 0.80	4.7 ± 0.40	3.7 ± 0.70
Overall Acceptability	3.7 ± 0.70	5.0 ± 0.00	3.8 ± 0.70

Flowability Properties of the Premix

The flow properties of the premix powders are summarised in Table 2. The bulk and tap densities were highest for the variant with moringa (combined blend), indicating tighter particle packing. For example, bulk density was 0.4545 g/mL for the control, 0.277 g/mL for the moringa variant, and 0.833 g/mL for the combined mix. The Carr’s compressibility index for the moringa-containing samples was 16.7% (Hausner ratio 1.20), reflecting good flow, whereas the control had a Carr’s index of 36.4% (Hausner 1.57), indicating poorer flow. A Hausner ratio near 1.2 indicates good flowability for a powder. Thus, adding moringa powder improved the flow characteristics of the premix. Overall, the moringa-fortified blends demonstrated better bulk density and flow properties than the control mixture.

Table 2 Flowability Properties of the Developed Premix

Property	Control	With Moringa	Combined
Bulk Density (g/mL)	0.4545	0.277	0.833
Tap Density (g/mL)	0.714	0.714	1.000
Carr’s Index (%)	36.36	16.67	16.67
Hausner Ratio	1.57	1.20	1.20

Nutritional Composition

Table 3 shows the proximate composition of the optimised premix. The optimised premix contained 76.7% carbohydrate, 11.2% fat, 1.02% protein, 1.12% fibre, and 7.56% moisture, providing 411.68 kcal/100 g. The product supplied 3.66 mg iron per 100 g, demonstrating its potential to contribute to dietary iron intake.

Table 3 Nutrient Composition of Optimised Premix

Nutrient	Amount (g/100g)
Carbohydrate	76.7%
Protein	1.02%
Fat	11.2%
Fiber	1.12%
Moisture	7.56%
Energy	411.68 kcal/100g
Iron	**3.66 mg/100g**

Phytochemical Analysis

Qualitative screening (Table 4) indicated that flavonoids and saponins were present in the premix, whereas alkaloids, phenols, and tannins were absent. The presence of flavonoids and saponins is consistent with the known bioactive components of moringa leaves. Flavonoids are known antioxidants, and saponins may have cholesterol-lowering effects. These phytochemicals could contribute additional health benefits to the fortified premix.

Table 4 Phytochemical Composition of the Premix

Phytochemical	Status
Flavonoids	Present
Saponins	Present

Source: Alkaloids, Phenols, and Tannins were absent.

Conclusion

Fortification of little millet dosa premix with moringa leaf powder improved nutritional quality while maintaining desirable sensory properties. The optimised formulation showed good consumer acceptability, favourable flow properties, and useful phytochemicals. The developed premix can serve as a convenient functional food. Thus, the little millet–moringa dosa premix shows strong potential as a food that contributes to nutritional security and dietary diversification.

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