



Formulation and Evaluation of Multi-millet Pancake Premix: A Plant-based Functional Food

Prasanna Gaikwad¹, Jyotsna Yadav², Haritha Das¹, Atharva Babar³

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ABSTRACT

Background: Rising global health concerns and diet-related non-communicable diseases have intensified interest in functional foods. Finger millet [*Eleusine coracana* (L.) Gaertn.] and barnyard millet (*Echinochloa frumentacea*) offer high dietary fiber and micronutrients, while moong dal (*Vigna radiata* (L) provides plant-based protein. This study aimed to develop a multi-millet pancake premix from finger millet, barnyard millet, moong dal, blended with flax seeds, pumpkin seeds, sunflower seeds, milk powder, cocoa powder and sugar for nutritionally enhanced products.

Methods: Three preliminary flour combinations were optimized using sensory analysis with a 9-point hedonic scale. The resulting multi-millet premix was analyzed for nutritional properties. Accelerated shelf-life testing was conducted at 40±2°C and 75±5% relative humidity for sixty days.

Result: The optimized multi-millet premix contained per 100 g: 13.04 g protein, 78.05 g carbohydrates, 3.35 g fat, 3.24 g ash, 2.24 g crude fiber, 0.02% saturated fatty acid, 1.28% monounsaturated fatty acid and 0.96% polyunsaturated fatty acid. Total energy was 394.5 kcal. Stability testing under recommended cool, dry storage conditions demonstrated a shelf life of 6 months, with all critical quality parameters remaining within acceptable specifications throughout this period. The formulated multi-millet premix demonstrated a favorable nutritional profile and sensory acceptability, with confirmed stability. Characterized by high protein content and supplemented with PUFAs from oilseeds, it represents a healthier nutritional alternative to conventional carbohydrate-based staple foods.

Key words: Antioxidant activity, Functional food, Millet, Multi-millet premix, Pancake, Shelf life.

INTRODUCTION

Urbanization drives a dietary transition from conventional, nutritious foods to contemporary alternatives characterized by high energy density, high fat content, simple sugars and high sodium levels (Obilana and Manyasa, 2002). Consequently, there is a critical need for novel, nutrient-dense whole-grain foods that are compatible with current lifestyles and require minimal preparation time (Premavalli *et al.*, 1987). While whole grains offer established benefits, multigrain breakfast blends take it a step further by synergistically combining diverse grains, leveraging their unique nutritional, sensory and functional properties for enhanced health and diet quality. Reflecting a global trend, consumers, particularly in India, prioritize convenience, favoring ready-made foods that need minimal cooking time or skill. Ready-to-eat multigrain blends offer a solution, boosting both the nutritional value and convenience of such staples (Pradeep *et al.*, 2014). Pancakes are a globally popular snack, typically consumed at breakfast and characterized by high carbohydrate and low fiber content. Substituting traditional, predominantly millet-based ingredients in such recipes with bio-functional alternatives has been demonstrated to enhance the nutritional profile of various food products and reduce their environmental impact (Sahu *et al.*, 2015).

Millets, pulses and oilseeds are ideal for functional foods because they deliver concentrated nutrition (proteins, amino acids, fiber, vitamins, minerals), beneficial bioactive

¹Department of Swasthavritta Evam Yoga, Dr. D.Y. Patil College of Ayurved and Research Centre, Dr. D. Y. Patil Vidyapeeth (Deemed to be university), Pune-411 018, Maharashtra, India.

²Department of Swasthavritta Evam Yoga, Bharati Vidyapeeth (Deemed to be University), College of Ayurved and Research Centre, Pune-411 038, Maharashtra, India.

³Department of Food Technology, Founder and Owner of Litmeals, Satara-415 001, Maharashtra, India.

Corresponding Author: Prasanna Gaikwad, Department of Swasthavritta Evam Yoga, Dr. D.Y. Patil College of Ayurved and Research Centre, Dr. D. Y. Patil Vidyapeeth (Deemed to be university), Pune-411 018, Maharashtra, India.

Email: prasannagaikwad07@gmail.com

ORCIDs: 0009 0005 7067 2587, 0009 0001 8594 817X, 0009 0005 0313 6047

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compounds (especially antioxidants) and sustainable cultivation, fulfilling key requirements for functional ingredients (Amadou, 2022; Tripathi *et al.*, 2021). Millet refers to a variety of small-seeded, short-growing plants valued for their nutritious, high-yield seeds consumed by humans and livestock. Known for its high nutritional value,

this crop thrives in hot, dry conditions and is particularly suited to semi-arid regions (Paschapur *et al.*, 2021). Gaining recognition as versatile, emerging food ingredients, millets produce whole grain flours characterized by distinct chemical compositions, starch digestibility and physicochemical properties (Tomar *et al.*, 2022). Compared to staple cereals like wheat and rice, which can lead to deficiencies in various nutrients, dietary fiber and antioxidants (Ritchie *et al.*, 2018; Kumar and Kumar, 2020), millets are recognized for their nutritional density and abundance of health-promoting functional compounds (Saleh *et al.*, 2013). Their high concentrations of micronutrients, dietary fiber, vitamins and phytochemicals with wide therapeutic applications (Kumar *et al.*, 2018) position them as crucial alternative grains for enhancing food and nutritional security worldwide. Millets possess significant potential to aid in achieving Sustainable Development Goals (SDGs) due to their exceptional nutrient and bioactive content. This potential includes supplying nutritious alternatives for Zero Hunger (SDG 2), contributing to Good Health and Well-being (SDG 3) and promoting sustainable food systems for Responsible Consumption and Production (SDG 12) (Cernev and Fenner, 2020).

Finger millet is rich in essential nutrients, consisting of approximately 65-75% carbohydrates, 5-8% protein, 1-2% fat, 15-20% dietary fiber and 2.5-3.5% minerals (Devi *et al.*, 2014). With an energy content of 300-350 kcal, finger millet is rich in phytochemicals, including polyphenols, flavonoids and tannins, contributing to its value in foods and nutraceuticals (Chandra *et al.*, 2016). Barnyard millet, a nutrient-dense minor cereal, provides higher protein (10.5%), fat (3.6-3.8%), carbohydrates (51.5-62 g/100 g) and energy (398 kcal/100 g) than major cereals (Shanmugapriya and Nazni, 2020). It contains significant crude fiber (5.41-6.8%) and total dietary fiber (12.6%: 4.2% soluble, 8.4% insoluble) (Ugare *et al.*, 2014). Rich in essential fatty acids (linoleic, palmitic, oleic) and minerals (iron, calcium, magnesium, zinc), its magnesium and niacin (B3) content helps lower cholesterol, while phosphorus aids metabolic energy conversion (Bharati *et al.*, 2005; Chandel *et al.*, 2014).

To improve the nutritional profile, incorporating a pancake premix along with additional ingredients like moong dal, flax seeds, sunflower seeds and pumpkin seeds offers significant potential. Flaxseeds contribute proteins, dietary fiber, fatty acids (especially α -linolenic acid), vitamins, minerals, phenolics, flavonoids, lignans and other bioactive components that collectively help prevent cardiovascular disease, cancer and diabetes (Kausar *et al.*, 2024). Sunflower seeds are highly nutritious, containing 20% protein, healthy fats, fiber, vitamin E and essential minerals like selenium, copper, zinc and iron (Rehman *et al.*, 2021). Pumpkin seeds are also densely packed with amino acids, phytosterols, unsaturated fatty acids, phenolic compounds, tocopherols, cucurbitacin's and valuable minerals. Together, these nutrient-dense seeds provide a comprehensive array of bioactive

compounds that are essential for maintaining optimal health and overall well-being, making this premix an excellent choice for nutritional enhancement (Dotto and Chacha, 2020). The objective of the study was to develop a premix using finger millet, barnyard millet, moong dal, flax seeds, pumpkin seeds and sunflower seeds and to evaluate their efficacy in terms of value addition. Premixes were incorporated into pancakes and analyzed for nutritional and sensory quality. This mix offers a health-promoting alternative that can be easily incorporated into regular diets without major calorie increases. It bridges tradition and modernity, providing convenient access to the grain's benefits through familiar formats. The millet mix aligns with growing consumer demand for plant-based, gluten-free options and minimally processed, functional foods.

MATERIALS AND METHODS

This research was conducted from January to December 2024. Formulation development and premix preparation occurred at the Department of Food technology, MIT ADT University, Pune, Maharashtra, India. Analytical testing was performed at Kulkarni Laboratories (NABL-accredited), Pune.

Ingredient procurement and preparation

Commercial-grade finger millet [*Eleusine coracana* (L.) Gaertn.], barnyard millet (*Echinochloa frumentacea*), green gram (*Vigna radiata* L.) and a seed mix comprising flax seeds (*Linum usitatissimum*), sunflower seeds (*Helianthus annuus*) and pumpkin seeds (*Cucurbita pepo*) were procured from certified suppliers in the local market of Satara, Maharashtra, India. Milk powder, cocoa powder (*Theobroma cacao*), food-grade xanthan gum and sodium bicarbonate (baking soda) were obtained from standard commercial sources. All ingredients were verified for quality parameters and stored under appropriate conditions before processing.

Formulation development

Three multi-millet mix (MMM) variants with varying ingredient compositions were developed through systematic optimization. Formulation employed structured experimental design evaluating different combinations of millet flours, legume flour and seed blends to achieve optimal nutritional profiles and functional properties (Geetha *et al.*, 2023). Three samples (Table 2) were developed and evaluated using nine-point hedonic scale sensory analysis. The formulation with highest overall acceptability was selected for comprehensive nutritional analysis.

Preparation of premixes

The selected grains, including barnyard millet (*Echinochloa esculenta*), finger millet (*Eleusine coracana*), green gram (*Vigna radiata*) and seeds comprising flax (*Linum usitatissimum*), sunflower (*Helianthus annuus*) and pumpkin (*Cucurbita pepo*), were subjected to systematic processing. Initial cleaning involved manual sorting to remove foreign matter, stones and damaged grains,

followed by thorough washing with potable water until the rinse water remained clear. The cleaned materials were soaked in distilled water at a 1:3 (w/v) ratio for 12 hours at ambient temperature to facilitate hydration and improve subsequent processing efficiency.

Following soaking, the hydrated grains and legumes were drained and dried. After drying, materials were ground using a hammer mill fitted with a 100-mesh screen to achieve a uniform particle size distribution, following standard millet processing protocols (Pawase *et al.*, 2019). The resulting flours were sieved through an 80-mesh sieve to ensure particle size consistency and remove any coarse

fragments. Seeds were processed separately through dry roasting before grinding to enhance the flavor profile and reduce anti-nutritional factors. Three formulations (S1, S2, S3) were developed based on preliminary trials evaluating binding properties, moisture retention, texture and fluffiness, with ingredient proportions determined from nutritional targets established through a literature review. Formulation S1 represented a balanced composition with 22% barnyard millet, 18% finger millet, 18% green gram, 8% seed mix, 22% milk powder, 8% cocoa powder, 2% baking soda and 2% xanthan gum. Formulation S2 featured elevated millet content (30% barnyard millet, 25% finger millet) with reduced milk powder (12%), while S3 employed moderate enrichment levels as detailed in Table 1.

The dry blending process followed a sequential mixing protocol where millet flours were combined first, followed by gradual incorporation of legume flour, processed seed mix and functional ingredients, including milk powder, cocoa powder, baking soda and xanthan gum. Uniform blending was achieved through manual mixing for approximately 20-30 minutes, using thorough hand-stirring techniques to ensure complete distribution of all ingredients. The prepared multi-millet pancake premix samples were packaged in 25-micron aluminum laminate pouches under controlled atmospheric conditions and stored at ambient temperature ($25\pm 2^{\circ}\text{C}$) with relative humidity below 65% for immediate analysis (Fig 1).

Preparation of pancakes

Premix (100g) was reconstituted with water (95ml) through vigorous whisking for 2-3 minutes. Batter was distributed onto preheated non-stick surface and cooked at 180°C for approximately 1.5 minutes per side until golden brown (Fig 2).

Sensory evaluation

Consumer acceptance was evaluated by 15 untrained panelists at Dr. D.Y. Patil College of Ayurveda and Research Centre. Pancakes were prepared from 5 g premix with 25ml water, cooked until golden brown and served warm.

Raw material procurement



Fig 1: Process flow diagram for pancake premix formulation.

Table 1: Ingredient composition for the pancake premix formulation per 100 g.

Ingredients (Latin name)	MMM (S1) ^a %	MMM (S2) ^b %	MMM (S3) ^c %
Barnyard millet (<i>Echinochloa frumentacea</i>)	22	30	25
Finger millet (<i>Eleusine coracana</i>)	18	25	20
Green gram (<i>Vigna radiata</i>)	18	12	15
Seed mix	8	15	10
-Flax seeds (<i>Linum usitatissimum</i>)			
-Sunflower seeds (<i>Helianthus annuus</i>)			
-Pumpkin seeds (<i>Cucurbita pepo</i>)			
Milk powder	22	12	20
Cocoa powder (<i>Theobroma cacao</i>)	8	3	5
Baking soda (Sodium bicarbonate)	2	1.5	2
Xanthan gum	2	1.5	3

MMM= Multi-millet mix.

^aS1= Sample 1 (Selected optimal formulation); ^bS2= Sample 2; ^cS3= Sample 3.

Panelists assessed appearance, color, aroma, texture, taste, aftertaste and overall acceptability using standardized 9-point hedonic scale ranging from 9 ('Like extremely') to 1 ('Dislike extremely'). Mean scores with standard deviations were calculated and statistically analyzed.

Proximate analysis

All proximate analyses were conducted at Kulkarni Laboratories (NABL-accredited) following standard methods. Moisture content was determined using gravimetric method (FSSAI 03.006:2023) at 105°C until constant weight. Total ash was measured following FSSAI 03.011:2023 at 550°C for 4-6 hours. Fat content was analyzed using Soxhlet extraction with petroleum ether. Protein content was determined using Kjeldahl method (IS 7219). Carbohydrates were calculated by difference: $100 - (\text{Protein}\% + \text{Fat}\% + \text{Ash}\% + \text{Moisture}\%)$ (AOAC, 2005). Total sugar was determined using Lane-Eynon method. Sodium content was analyzed using flame photometry at 589nm wavelength.

Fatty acid profile analysis

Fatty acid analysis was performed according to AOAC Official Method 996.06 (AOAC, 2000). Total lipids were extracted using modified Folch method with chloroform: methanol (2:1, v/v). Fatty acid methyl esters were prepared by transesterification using boron trifluoride-methanol reagent at 100°C for 30 minutes.

Cholesterol analysis

Cholesterol content was determined using AOAC Official Method 994.10 involving saponification with ethanolic potassium hydroxide, followed by petroleum ether extraction and gas chromatography quantification.

Crude fiber determination

Crude fiber was analyzed by sequential digestion with dilute sulfuric acid (1.25%) and sodium hydroxide (1.25%) solutions. The insoluble residue was filtered, dried, weighed and ashed to determine crude fiber content gravimetrically.

Antioxidant activity

DPPH radical scavenging activity was evaluated using Mensor *et al.* (2001) method. Sample solutions (0.5mL) were mixed with 4.5 mL of 0.002% DPPH in alcohol. Following 30-minute incubation in darkness at room temperature, absorbance was measured at 517 nm.

Shelf life

Multigrain premix packaged in 25-micron aluminum laminate pouches underwent accelerated shelf-life testing in Environmental Chamber (Ocean Life Science Corp., Model OLSC-116E) at 40±2°C and 75±5% relative humidity.

Statistical analysis

Descriptive statistical analysis evaluated sensory characteristics. Mean values and standard deviations were calculated for each sensory parameter.

RESULTS AND DISCUSSION

Optimization of multi-millet premix

Three distinct formulations (MMM S1, S2 and S3) were systematically developed with varying ingredient proportions to evaluate their influence on product quality and consumer acceptance. Following a comprehensive sensory evaluation, the S1 formulation demonstrated superior performance and was selected as the optimal combination. The finalized S1 formulation consisted of barnyard millet (*Echinochloa esculenta*) 25%, finger millet (*Eleusine coracana*) 20%, green gram (*Vigna radiata*) 15%, seed mixture comprising flax seeds (*Linum usitatissimum*), sunflower seeds (*Helianthus annuus*) and pumpkin seeds (*Cucurbita pepo*) 10%, milk powder 20%, cocoa powder (*Theobroma cacao*) 5%, sodium bicarbonate 2% and xanthan gum 3%. The optimized S1 formulation was subsequently analyzed for physicochemical properties and nutritional composition.

The formulation success stemmed from strategic ingredient balancing. The 45% combined millet content represented a critical balance point. Previous research has established that millet incorporation beyond 50% in composite flour products often compromises sensory acceptability due to the accumulation of phenolic compounds that impart astringency (Saleh *et al.*, 2013). Green gram incorporation at 15% proved strategically important for protein enhancement. Pulse addition exceeding 20% in cereal-based products increases batter viscosity and prolongs cooking time due to modified starch-protein interactions and altered water absorption properties (Bresciani *et al.*, 2022). The 10% oilseed mixture served nutritional enhancement and functional improvement. This proportion falls within the range reported as optimal for omega-3 enrichment (Kajla *et al.*, 2015), particularly α -linolenic acid from flax seeds. Overall, S1 formulation achieved the essential balance between nutritional enhancement and organoleptic acceptability that determines consumer adoption of functional foods (Bigliardi and Galati, 2013).

Sensory evaluation

Sensory characteristics of pancakes from three multi-millet premix formulations were evaluated using 9-point hedonic

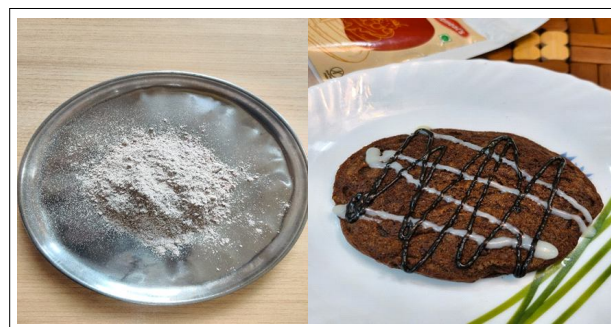


Fig 2: a) Formulated premix, b) Multi-millet pancake: Post-cooking.

scale (Table 2). All formulations demonstrated high consumer acceptability with mean scores exceeding 8.0 across all attributes (Fig 3,4). Sample S1 exhibited superior sensory performance, achieving highest scores for taste/ flavor (9.0 ± 0.64), color (9.07 ± 0.64), texture/mouthfeel (8.87 ± 0.62) and overall acceptability (8.87 ± 0.46). Based on comprehensive sensory assessment, Sample S1 was identified as optimal formulation with superior organoleptic properties and highest consumer preference.

Proximate composition analysis

The proximate composition analysis of the food sample revealed significant nutritional characteristics (Table 3). The moisture content was determined to be 2.32%, indicating a relatively dry product with good storage stability. This low moisture level is consistent with processed food products designed for extended shelf life and reduced risk of microbial growth. The total ash content of 3.24% represents the

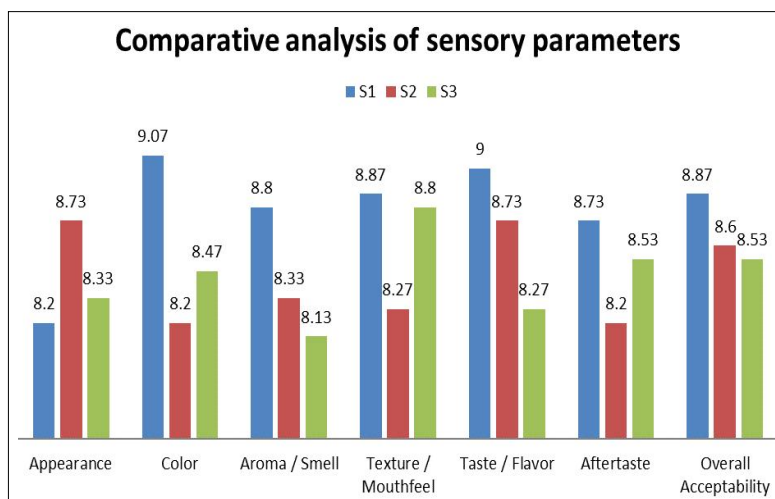


Fig 3: Comparative analysis of sensory parameters presented as a bar chart.

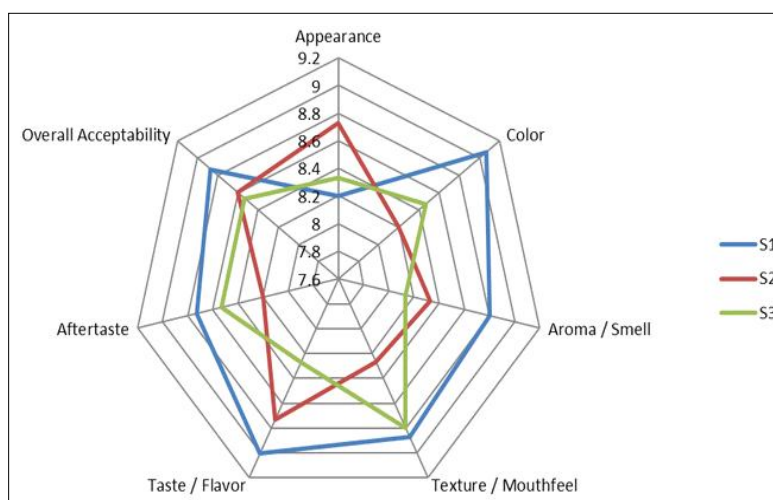


Fig 4: Radar plot depicting comparative sensory profiles of three developed samples.

Table 2: Sensory evaluation of pancakes prepared from multi-millet premix formulations.

Product	Appearance	Color	Aroma/ smell	Texture/ mouthfeel	Taste/ flavor	Aftertaste	Overall acceptability
S1	8.2±0.41	9.07 ± 0.64	8.8±0.59	8.87±0.62	9±0.64	8.73±0.41	8.87±0.46
S2	8.73±0.46	8.2 ± 0.56	8.33±0.49	8.27±0.46	8.73±0.46	8.2± 0.56	8.6±0.51
S3	8.33±0.49	8.47 ± 0.74	8.13±0.35	8.8±0.41	8.27±0.7	8.53 ± 0.64	8.53±0.64

Values are expressed as mean ± standard deviation (n=15).

Sensory scores based on 9-point hedonic scale: 9= Like extremely, 8= Like very much, 7= Like moderately, 6= Like slightly, 5= Neither like nor dislike, 4= Dislike slightly, 3= Dislike moderately, 2= Dislike very much, 1= Dislike extremely.

Table 3: Proximate composition and nutritional parameters of optimized multi-millet pancake premix.

Parameter	Value	Unit
Proximate composition		
Moisture	2.32	%
Total ash	3.24	%
Total fat	3.35	%
Protein	13.04	%
Total carbohydrates	78.05	%
Crude fiber	2.24	%
Total sugar (as sucrose)	6.35	%
Energy value	394.5	kcal per 100 g
Sodium	358	mg per 100 g
Fatty acid profile		
Saturated fatty acids (SFA)	0.72	%
Monounsaturated fatty acids (MUFA)	1.28	%
Polyunsaturated fatty acids (PUFA)	0.96	%
Trans fatty acids	<0.1	%
Cholesterol	<5	mg per 100 g
Antioxidant and shelf life		
Antioxidant activity (DPPH)	1.85	PPM
Shelf life	6	Months

All values expressed on dry weight basis per 100 g of premix.

mineral content of the sample, it falls within the typical range for processed food products, indicating moderate mineral density. The relatively low ash content suggests that the product is not heavily fortified with mineral supplements.

The total carbohydrate content of 78.05% indicates that this product is predominantly carbohydrate-based, characteristic of cereal or grain-derived foods. This high carbohydrate percentage suggests the product could serve as a significant energy source in dietary applications. The sugar content analysis revealed 6.35% total sugar as sucrose, indicating moderate sweetness levels that may enhance palatability without excessive sugar loading. Protein content (13.04%) represented a substantial enhancement over conventional wheat-based pancake mixes (typically 5-7%), derived from synergistic contributions of barnyard millet (10.5%), finger millet (7-8%), green gram (24%), milk powder (26%) and oilseeds (18-25%). The enhanced protein content aligns with findings from similar millet-based composite mixes reported in the literature (Baruah, 2024). This multi-source protein approach provides improved amino acid balance through complementarity, where green gram supplies lysine (6.8-7.2 g/100 g protein) deficient in cereals, while millets contribute sulfur-containing amino acids lacking in legumes (Shukla and Srivastava, 2014).

Fat content and fatty acid profile

The total fat content (3.35%) indicates a low-fat formulation with health-promoting lipid composition (Table 3): monounsaturated fatty acids 1.28% (38% of total fat), polyunsaturated fatty acids 0.96% (29%), saturated fatty

acids 0.72% (21%) and trans fatty acids <0.1% (undetectable). This yields an unsaturated: saturated ratio of 3.1:1 and a PUFA:SFA ratio of 1.33:1, substantially exceeding cardiovascular disease prevention recommendations. The predominance of unsaturated fats stems from the strategic oilseed blend, with flax seeds providing α -linolenic acid (estimated at 0.15-0.25% ALA), which is rare in cereal-based foods (Goyal *et al.*, 2014). The resulting omega-6:omega-3 ratio approximates 3.2:1, approaching the recommended 1-4:1 for optimal health outcomes, whereas Western diets typically exceed 10:1 (Simopoulos, 2016).

The absence of detectable trans fats represents a significant nutritional advantage, as each 2% energy increase from trans-fat is associated with 23% increased coronary heart disease risk (Mozaffarian *et al.*, 2010). The strategic inclusion of oilseeds not only enriches the fatty acid profile but also contributes to the overall functional properties of the premix, enhancing texture and mouthfeel while providing essential fatty acids that support cardiovascular health and reduce inflammation.

Energy content

The calculated energy value of 394.5 kcal per 100g indicates high-energy-density product, primarily from substantial carbohydrate content. The high energy density makes this premix particularly relevant for addressing energy-protein malnutrition in vulnerable populations. From nutritional security perspective, energy-dense millet-based foods provide sustained energy through complex carbohydrates while delivering essential micronutrients often deficient in energy-dense processed foods.

Fiber content

Crude fiber content of 2.24% represents moderate dietary fiber contribution, consistent with processed millet-based products. While not exceptionally high, this fiber level provides meaningful health benefits when contextualized within total dietary intake patterns. A 50 g serving would contribute approximately 1.12 g (4-5% of daily 25-30 g requirements), complementing fiber from other dietary sources.

Cholesterol and sodium analysis

Cholesterol content was below detectable limits (<5 mg per 100 g), indicating suitability for cholesterol-restricted diets. However, sodium content of 358 mg per 100 g is relatively high and should be considered in context of daily sodium intake recommendations, particularly for individuals with hypertension or cardiovascular concerns.

Antioxidant activity

Antioxidant activity analysis (1.85 PPM) indicates presence of bioactive compounds at moderate levels. Recent reports indicate that millets contain significant antimicrobial, anti-inflammatory, antiviral and anticancer properties (Khan *et al.*, 2025). Total phenolic content in minor millets ranges from 53.28 to 110.42 mg GAE/g with corresponding antioxidant activities (Jenipher *et al.*, 2024).

Shelf Stability and commercial viability

Accelerated shelf-life testing at $40\pm 2^{\circ}\text{C}$ and $75\pm 5\%$ relative humidity revealed projected shelf life of 6 months when stored in cool and dry conditions (Table 3). Quality parameters including moisture content, water activity and microbial count remained within acceptable limits throughout testing. The 6-month shelf life is commercially viable for distribution, retail and consumer use while ensuring product safety and quality maintenance.

Implications for food security

Millet is recognized for their climate resilience, thriving in arid and semi-arid conditions, this agricultural advantage, combined with their superior nutritional profile, positions millets as crucial for achieving Sustainable Development Goals, particularly SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-being) and SDG 12 (Responsible Consumption and Production) (Kumar *et al.*, 2024). Urbanization has driven a dietary transition toward high-energy, nutrient-poor convenience foods (Agregán *et al.*, 2023). Products like this premix offer a health-promoting alternative.

Limitations

Several limitations warrant acknowledgment. The study did not quantify specific bioactive compounds. Also, glycemic index is required for empirical determination through clinical trials. This, long-term consumer acceptance studies across diverse demographic groups would strengthen market viability assessments.

CONCLUSION

The ready-to-cook pancake premix, formulated from millets, pulses and oilseeds, constitutes a convenient and nutritious enhancement for daily diets. Characterized by high protein content and supplemented with PUFAs from oilseeds, it presents a healthier pancake option. This product facilitates maintenance of balanced diet and assists in addressing lifestyle-related health issues, including obesity. Furthermore, its antioxidant properties and promotion of healthy gut microbiota contribute significantly to overall health, enabling improved dietary habits with retained palatability and convenience.

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Disclaimers

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Informed consent

No animal procedures and experiments were done.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data collection, analysis, decision to publish, or preparation of the manuscript.

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