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Development and quality evaluation of microgreen incorporated foxtail and banana-based soup mix powder

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Abstract
Instant soup mix powder is a convenient and nutritious ready-to-cook food product developed to provide quick preparation, good sensory acceptability and nutritional value. The present study aimed to develop and evaluate a microgreen incorporated foxtail millet and raw banana based instant soup mix powder with improved nutritional and sensory qualities. Different formulations of instant soup mix were prepared in six formulations (T0-T5). Sensory evaluations were carried out using a nine-point hedonic scale by a semi-trained panel of 15 judges. Among the formulations T3 was recorded the highest total mean sensory score of 8.81, which contains foxtail powder and raw banana powder (15%), Mushroom powder (5%), Corn flour (20%), Defatted soy flour (5%), dehydrated carrots (10%) and radish microgreens (5%), milk powder (10%), garlic powder (3%), onion powder (5%), pepper (2%), and salt (5%). The selected formulation was selected for nutritional analysis, shelf-life study and microbial analysis. Nutritional analysis revealed carbohydrate content of 41.57g/100g, protein 6.25g/100g, fat 2.98g/100g, crude fibre5.15g/100g, calcium 111.28mg/100g, potassium 92.31mg/100g, iron 3.90mg/100g, moisture 6.8g/100g, ash 7.24g/100g, carotenoid 0.246mg/g and energy 215.91 kcal.

Keywords: Instant soup mix, foxtail, raw banana, microgreens, defatted soy flour, mushroom powder

Introduction
In food science and nutrition, functional foods have become a major field of study. Functional foods, which are frequently enhanced with vitamins, minerals, probiotics, or fibre, provide health advantages beyond simple nutrition (Marcìa-Fuentes *et al*., 2026). In recent years, functional soup mixes have drawn a lot of attention as nutrient-dense, handy solutions that combine the advantages of conventional soups with specific health-promoting additives. According to recent evaluations, soup premixes are adaptable transporters of bioactive compounds made from legumes, vegetables, and agro-industrial byproducts, enhancing their functional qualities and nutritional value. (Shinde, 2025) [15].

Instant soup mixes have drawn a lot of interest as practical functional foods that combine nutritional advantages with simplicity of preparation. The market share of plant-based convenience foods has increased, but many of them are low in nutrients and excessive in fat, salt, and sugar, underscoring the need for healthier formulations. (Pamalka *et al.*, 2026) [10]. The present study aims to develop a nutrient-dense instant soup mix using foxtail millet powder and raw banana powder as primary ingredients, fortified with defatted soy flour, radish microgreens, and mushroom powder

Foxtail millet (*Setaria italica* L.) is a gluten-free pseudo-cereal cultivated across Asia, Africa, and South America, known for its excellent nutritional characteristics (Farzana *et al*., 2024) [5]. While green banana powder is recognized for its abundant reserves of resistant starch, potassium, minerals, phenolic compounds, and antioxidants (Lorenzo *et al*., 2024) [7]. Defatted soy flour contributes high-quality protein and dietary fiber, supporting cholesterol reduction and prevention of obesity and diabetes (Xiao, 2011) [18]. Radish microgreens provide significant antioxidants, vitamin C, and glucosinolates with demonstrated anticancer and anti-inflammatory properties (Tilahun *et al*., 2024) [16]. And mushroom powder contributes bioactive polysaccharides, phenolics, and flavonoids alongside a natural umami flavor that enhances the sensory quality of the product (Saed *et al*., 2022) [13].

Materials and Methods
Materials and Chemicals
Foxtail millet powder, button mushrooms, raw bananas, defatted soy flour, Carrots and Radish seeds were purchased from the local market. Other ingredients, including onion powder, garlic powder, pepper powder, milk powder, salt, and corn flour, were also purchased from the local market. All chemicals used in the nutritional analysis were of analytical grade.

Methods
Raw Materials and Instant Soup Mix Manufacturing
Raw bananas were collected. The outer peel was separated, followed by thorough washing and cleaning. The bananas were then subjected to an anti-browning treatment by dipping in citric acid solution. After slicing, the banana slices were dried at 50–60°C for 12–24 hours. The dried slices were ground into powder, sieved to obtain uniform particle size, and stored in airtight containers for further use.

Fresh button mushrooms (Agaricus bisporous) were collected, thoroughly washed, and the unwanted parts were removed. The mushrooms were then dried at 65 °C for 10-12 hours until a final moisture content of less than 5% was achieved. The dried mushrooms were ground into a powder and sieved through a 0.5 mm mesh to obtain a fine, uniform texture. The resulting mushroom powder was stored in airtight containers and kept in a cool, dry place to preserve quality and extend shelf life.

Fresh carrots were collected and thoroughly washed to remove dirt and other impurities. The carrots were then cleaned, peeled, and unwanted portions were removed before slicing into uniform pieces. Prior to dehydration, carrot slices were blanched in boiling water for 4 minutes. After blanching, the carrot slices were dried at 50 °C for 10–12 hours until adequate drying was achieved. The dried carrot slices were then cooled to room temperature and packed in airtight containers for storage and further use.

Organic radish seeds sown in standard growing trays and harvested on the seventh day post-germination at the cotyledon stage. The freshly harvested microgreens were sorted, washed under clean running water and dried at a temperature of 65°C for 1 to 2 hours. Following dehydration, the dried microgreens were cooled to room temperature and stored in airtight containers

Six formulations of instant soup mixes designated as T0 (control), T1, T2, T3, T4, and T5 were prepared by varying the proportions of foxtail millet flour, raw banana powder and corn flour, while keeping other ingredients constant. (Table 1)

Table 1: ingredient composition of different treatments instant soup mix

Ingredients	T0	T1	T2	T3	T4	T5
Foxtail powder	-	5	10	15	20	25
Raw banana powder	-	5	10	15	20	25
Mushroom powder	5	5	5	5	5	5
Corn flour	50	40	30	20	10	-
Defatted soy flour	5	5	5	5	5	5
Dehydrated carrots	10	10	10	10	10	10
Dehydrated microgreens	5	5	5	5	5	5
Milk powder	10	10	10	10	10	10
Garlic powder	3	3	3	3	3	3
Onion powder	5	5	5	5	5	5
Pepper	2	2	2	2	2	2
Salt	5	5	5	5	5	5

The instant soup mix powder was prepared by mixing foxtail powder and raw banana powder with spices and other ingredients. The mixture was blended uniformly and roasted for one minute. It was then filled, packed and stored in an airtight container. The instant soup was prepared by boiling 10 g of soup powder in 150 ml of water until a uniform consistency was obtained.

Sensory Analysis

Sensory evaluation of developed instant soup mix powder was evaluated by using a 9-point hedonic scale where 9 indicated 'like extremely' and 1 indicated 'dislike extremely' with 15 untrained panelists. Product was evaluated on the basis of texture, color, taste, flavor, appearance and overall acceptability.

Nutritional Analysis

Estimation of Moisture, Carbohydrate, Protein, Fat, Fibre, Ash and Energy

The treatment that obtained the highest sensory evaluation score (T3) was selected for nutritional analysis.

Moisture content was estimated according to AOAC (2023) [1]. About 2g of sample weighed and dried in hot air oven at 105°C until constant weight is obtained.

The total carbohydrate content was estimated by Anthrone method of Sadasivam and Manickam (1992). The absorbance was measured at 630 nm and the carbohydrate content was calculated using a standard glucose curve and expressed as g/100g of sample.

Protein content was determined according to the Kjeldahl method as described by AOAC (2023) [1]. The sample was digested with concentrated sulfuric acid in the presence of a catalyst, followed by distillation and titration of the released ammonia nitrogen, and the crude protein content was calculated by multiplying the total nitrogen value by a conversion factor of 6.25.

Fat content was determined using the Soxhlet extraction method as described by AOAC (2023) [1]. The dried sample was extracted continuously with petroleum ether (or diethyl ether) in a Soxhlet apparatus for 6 hours, after which the solvent was evaporated, and the residual crude fat was weighed and expressed as a percentage of the original sample weight.

Crude fibre content was estimated by the acid-alkali digestion method described by Chopra and Kanwar (1978)

Total ash content was determined according to AOAC (2023) [1] by incinerating the sample in a muffle furnace at 600°C.

The energy value of the samples was calculated using Atwater conversion factors, and all results were expressed on a per 100 g basis.

Estimation of Iron, Calcium and Potassium

Iron content was estimated by the colorimetric method using potassium thiocyanate, which forms a blood red complex with ferric ions (Raghuramulu *et al*., 2003) [12]. Absorbance was measured at 540 nm and iron content was calculated using a standard curve and expressed as mg/100 g.

Calcium content was estimated by the EDTA titration method by Page (1982) [9]. The sample was digested with nitric acid and perchloric acid mixture, and the extract was titrated with 0.02 N EDTA using calcone indicator until a permanent blue colour appeared. Calcium content was expressed as mg/100 g of sample.

Potassium content was estimated using a flame photometer as suggested by Jackson (1973) [6].

Estimation of Carotenoid

Total carotenoids were determined by extracting 1 g of sample with acetone followed by filtration under vacuum. The extract was transferred to petroleum ether, washed with ultrapure water to remove acetone, and dried using anhydrous sodium sulfate. The volume was made up with petroleum ether and absorbance was measured at 450 nm.

Results

Sensory Evaluation of Instant Soup Mix Powder

Table 2: Mean sensory score of instant soup mix powder treatments

Treatments	Appearance	Color	Flavor	Texture	Taste	Overall acceptability	Total mean score
T0	6.6	6.7	6.4	6.2	6.5	6.3	6.45
T1	7.3	7.5	7.5	7	7.4	7.3	7.33
T2	7.7	7.8	7.7	7.5	7.8	7.6	7.68
T3	8.8	8.8	8.9	8.9	8.7	8.8	8.81
T4	7.6	7.6	7.3	7.4	7.5	7.4	7.46
T5	7.5	7.3	7	7	7.2	7.2	7.2

The table 2 presents the mean sensory scores of different instant soup mix treatments (T0-T5) evaluated for appearance, color, flavor, texture, taste and overall acceptability. Among all the treatments, T3 obtained the highest scores in all sensory attributes with a total mean score of 8.81, indicating maximum consumer acceptability. T0 recorded the lowest mean score (6.45), showing lower preference among the panelists. The results suggest that T3 was the most acceptable formulation in terms of sensory quality.

Nutritional Composition of Selected Instant Soup Mix Powder (T3)

The nutritional compositions of the optimized instant soup mix formulation (T3) are shown in Table 3. The total energy value was 215.91 kcal with a carbohydrate content of 41.57 g/100 g, protein 6.25 g/100 g, fat 2.98 g/100 g, crude fibre 5.15 g/100 g, ash 7.24 g/100 g, and moisture 6.8g/100g. Mineral analysis revealed calcium at 111.28 mg/100 g, potassium at 92.31 mg/100 g, and iron at 3.90 mg/100 g. and carotenoid content was 0.246 mg/g

Table 3: nutritional composition of selected instant soup mix powder

Nutrient	Composition (T0)	Composition (T3)	p-value	Interpretation
Moisture (g/100g)	6.4	6.8	0.081	NS
Carbohydrate (g/100g)	47.80	41.57	0.002	S
Protein (g/100g)	3.20	6.25	< 0.001	S
Fat (g/100g)	2.35	2.98	0.041	S
Crude fibre (g/100g)	3.60	5.15	0.003	S
Ash (g/100g)	5.40	7.24	0.002	S
Iron (mg/100g)	2.63	3.90	< 0.001	S
Calcium (mg/100g)	79.50	111.28	< 0.001	S
Potassium (mg/100g)	64.21	92.31	< 0.001	S
Carotenoid (mg/g)	0.142	0.246	0.001	S
Energy (kcal)	222.89	215.91	0.018	S

Statistical interpretation

Statistical analysis between T0 and T3 indicated significant differences ($p < 0.05$) for carbohydrate, protein, fat, crude fibre, ash, iron, calcium, potassium, carotenoid and energy values, suggesting that incorporation of functional ingredients significantly improved the nutritional quality of the optimized instant soup mix formulation. Moisture content showed a non-significant difference ($p > 0.05$), indicating similar moisture stability between treatments.

Discussion

The composition of the treatments had a significant effect on the sensory quality of the instant soup mix powder, with the optimum ratio of foxtail millet powder and raw banana powder at 15 g each (T3) yielding the highest total mean sensory score of 8.81. The progressive increase in foxtail millet and raw banana powder from T0 to T3 improved flavor, texture, and overall acceptability, consistent with findings by (Peerkhan *et al*., 2024) [11], who reported that as the amount of foxtail millet in the soup increased, the flavour attribute score correspondingly rose, with overall acceptability scores ranging from 7.40 to 8.14

Scores declined in T4 and T5, suggesting that substitution beyond 15 g negatively affected sensory balance. This is consistent with previous studies on millet-based instant soup formulations, where enrichment with millets and herbs significantly increases the sensory and nutritional benefits, and the millet-incorporated treatment was found to be highly acceptable compared to the control (Tulasi *et al*., 2020) [17]

The nutritional analysis of T3 revealed a well-balanced proximate profile with 6.25 g/100g protein, 5.15 g/100g dietary fibre, and an energy value of 215.91 kcal. The mineral content was notably high, with calcium at 111.28 mg/100g and iron at 3.90 mg/100g, attributed to the combined contribution of foxtail millet, dehydrated microgreens, and carrots. Foxtail millet-based food products have been reported to receive the highest scores for overall acceptability, color, appearance, texture, and flavor, confirming the superior sensory and nutritional value of foxtail millet incorporation (Arora *et al.*, 2023) [2]. The carotenoid content of 0.246 mg/g further reflects the contribution of dehydrated carrots and microgreens as sources of provitamin A. Overall, T3 maintained the highest sensory scores and nutritional quality among all treatments, well above the minimum acceptable threshold.

The notable mineral and carotenoid content observed in T3 can be largely attributed to the inclusion of dehydrated

microgreens and dehydrated carrots as functional ingredients in the formulation. Studies have reported that microgreens contain significantly high concentrations of carotenoids, including β-carotene, lutein/zeaxanthin, and violaxanthin, and that their cotyledon leaves possess higher nutritional densities compared to mature leaves (Z. Xiao *et al.*, 2012) [19]. Furthermore, microgreens have been reported to exhibit high macro elements, with potassium ranging from 187.07 to 416.05 mg/100g FW and calcium from 67.18 to 148.63 mg/100g FW, which aligns well with the calcium (111.28 mg/100g) and potassium (92.31 mg/100g) values recorded in T3(Balik *et a*l., 2025) [3]. he irons content of 3.90 mg/100g further underscores the nutritional significance of these ingredients, making T3 not only sensorially superior but also a functionally enriched product suitable for addressing micronutrient deficiencies in the diet.

Conclusion

The present study concluded that the incorporation of foxtail millet powder and raw banana powder significantly influenced the sensory and nutritional quality of the developed instant soup mix powder. Among all the treatments, T3 containing 15 g each of foxtail millet powder and raw banana powder exhibited the highest overall sensory acceptability score (8.81), indicating optimum balance in flavour, texture, appearance, and overall acceptability. The results demonstrated that moderate incorporation of millet and banana powder enhanced the sensory characteristics, while excessive substitution negatively affected product acceptability. Nutritional evaluation of T3 revealed a well-balanced composition with appreciable amounts of protein, dietary fibre, minerals, and carotenoids. The high calcium, iron, and carotenoid contents were mainly attributed to the inclusion of dehydrated microgreens and carrots, which contributed to the functional and micronutrient-rich nature of the product. The study further confirmed that foxtail millet-based formulations can serve as nutritionally superior and sensorially acceptable convenience foods.

Overall, the developed microgreen-incorporated foxtail millet and raw banana based instant soup mix powder can be considered a promising functional food product with good consumer acceptability and enhanced nutritional benefits, suitable for promoting healthier dietary choices and helping address micronutrient deficiencies.

References

1. AOAC International. Official Methods of Analysis of AOAC INTERNATIONAL. 22nd ed. Latimer GW Jr, ed. Washington, DC: AOAC International, 2023, 3750.
2. Arora L, Aggarwal R, Dhaliwal I, Gupta OP, Kaushik P. Assessment of sensory and nutritional attributes of foxtail millet-based food products. Frontiers in Nutrition,2023:10:1146545.
3. Balik S, Elgudayem F, Dasgan HY, Kafkas NE, Gruda NS. Nutritional quality profiles of six microgreens. Scientific Reports,2025:15(1):6213.
4. Chopra SL, Kanwar JS. Analytical Agricultural Chemistry. 4th ed. New Delhi: Kalyani Publishers, 1976, 161–165.
5. Farzana T, Abedin MJ, Abdullah ATM, Reaz AH, Bhuiyan MNI, Afrin S, *et al*. Enhancing prebiotic, antioxidant, and nutritional qualities of noodles: A collaborative strategy with foxtail millet and green banana flour. PLOS ONE,2024:19(8):0307909.
6. Jackson ML. Soil Chemical Analysis. New Delhi: Prentice Hall of India Pvt. Ltd, 1973, 134–182.
7. Lorenzo M, Diaz PB, Romero D, Piedra-Buena Diaz A, Diaz Romero C, Rodriguez-Rodriguez EM, *et al*. Physicochemical and Nutritional Characterization of Green Banana Flour from Discarded Cavendish Bananas. Sustainability,2024:16(15):6647.
8. Marcia-Fuentes JA, Aleman RS, Areche FO, Flores DC, Roman AV, Martin-Verdejo D, *et al*. Functional foods: A review of foods ingredient and their health benefits. Food and Humanity,2020:6:100953.
9. Page AL, Miller RH, Keeney DR, editors. Methods of Soil Analysis. Part 2: Chemical and Microbiological Properties. 2nd ed. Madison, WI: American Society of Agronomy, 1982, 403–430.
10. Pamalka C, Raymond M, Gayan N, Brownlee IA, Liyanage GSG. Formulation and Nutritional Evaluation of Instant Vegan Mushroom (*Pleurotus ostreatus*) Soup Powder Enriched with Moringa (*Moringa oleifera*), Mung Bean (*Vigna radiata*), and Pumpkin (*Cucurbita maxima*). Foods,2026:15(3):445.
11. Peerkhan N, Pandey M, Bhandari Y. Formulation of prebiotic, low glycemic index millet soups using foxtail, barnyard and kodo millet. Discover Food,2024:4(1):62.
12. Raghuramulu N, Madhavan Nair K, Kalyanasundaram S. A Manual of Laboratory Techniques. 2nd ed. Hyderabad: National Institute of Nutrition, Indian Council of Medical Research, 2003, 56–58.
13. Saed B, El-Waseif M, Fahmy H, Shaaban H, Ali H, Elkhadragy M, *et al*. Physicochemical and Sensory Characteristics of Instant Mushroom Soup Enriched with Jerusalem artichoke and Cauliflower. Foods,2022:11(20):3260.
14. Sadasivam S, Manickam A. Biochemical Methods. 2nd ed. New Delhi: New Age International Publishers, 1996, 8–10.
15. Shinde RS. Comprehensive Review on Various Soup Premixes and its Functional Properties Related to Human Health. International Journal of Food and Fermentation Technology, 2025, 15(2).
16. Tilahun S, Baek MW, An KS, Choi HR, Lee JH, Tae SH, *et al*. Preharvest Methyl Jasmonate Treatment Affects the Mineral Profile, Metabolites, and Antioxidant Capacity of Radish Microgreens Produced without Substrate. Foods,2024:13(5):789.
17. Tulasi G, Deepika U, Venkateshwarlu P, Santhosh V, Srilatha P. Development of millet based instant soup mix and Pulav mix. International Journal of Chemical Studies, 2020, 8(5).
18. Xiao CW. Functional soy products. Functional Foods: Concept to Product: Second Edition, 2011, 534–556.
19. Xiao Z, Lester GE, Luo Y, Wang Q. Assessment of Vitamin and Carotenoid Concentrations of Emerging Food Products: Edible Microgreens. Journal of Agricultural and Food Chemistry,2012:60(31):7644–7651.