Development and Sensory Assessment of Nutrient-Dense Supplement Powder Enriched with Protein and Iron from Food Waste Sources

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Abstract: The increasing burden of malnutrition, particularly protein-energy malnutrition and iron deficiency anemia, necessitates sustainable and cost-effective nutritional interventions. This study aimed to develop a nutrient-dense supplement powder using underutilized food waste sources such as pea peels, jackfruit seeds, and cereal bran. The formulated products were evaluated for proximate composition and sensory acceptability. Four formulations (T1, T2, T3, and T4) were prepared with varying proportions of raw materials. Proximate analysis revealed that T3 exhibited the highest protein (18.6 g/100 g) and iron content (9.2 mg/100 g). Sensory evaluation using a 9-point hedonic scale indicated that T3 was the most acceptable formulation with significant differences ($p < 0.05$) among treatments. The study demonstrates that food waste-derived ingredients can be effectively utilized to produce affordable, nutritious supplements for combating malnutrition.

Keywords: Food waste utilization, protein supplement, iron enrichment, sensory evaluation, sustainable nutrition.

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1. Introduction

Food waste management and nutritional security are two critical global challenges (Wani et al., 2024). Large quantities of nutrient-rich food by-products such as vegetable peels, seeds, and bran are discarded despite their high nutritional potential (Liu et al., 2023). Pea peels are rich in dietary fibre and micronutrients, jackfruit seeds are a good source of protein and iron, while cereal bran provides essential minerals and bioactive compounds (Meghwal et al., 2018).

Iron deficiency anemia and protein-energy malnutrition remain prevalent in developing countries like India (Bhutia, 2014). Developing low-cost, nutrient-dense supplements using food waste can contribute to sustainable nutrition and reduce environmental burden.

Therefore, this study focuses on the development, nutritional evaluation, and sensory assessment of a supplement powder formulated from pea peels, jackfruit seeds, and cereal bran.

2. Materials and Methods

2.1 Sample Collection

Pea peels were collected from local vegetable markets, while jackfruit seeds were obtained from nearby fruit vendors, and cereal bran (wheat bran) was sourced from local flour mills. The selected raw materials represented commonly discarded food waste with high nutritional potential. All collected samples were carefully sorted to remove any damaged or spoiled portions and then thoroughly washed to eliminate dirt and impurities. Subsequently, the materials were subjected to drying under controlled conditions to reduce moisture content and prevent microbial growth. All handling and processing steps were carried out under hygienic laboratory conditions to ensure safety, quality, and suitability for further analysis and product development.

2.2 Preparation of Raw Materials

The collected raw materials were processed using standardized methods to obtain fine, stable powders suitable for formulation. Pea peels were thoroughly

washed, blanched to inactivate enzymes, and then dried at 60°C for 6 hours before being ground into a fine powder. Jackfruit seeds were first boiled to facilitate removal of the outer seed coat, followed by peeling, slicing, drying, and roasting to improve flavour and digestibility; the roasted seeds were then milled into powder form. Cereal bran was cleaned to remove any foreign particles and lightly roasted to enhance its sensory attributes and shelf stability. All powders were sieved uniformly and stored in airtight containers until further use in product formulation.

Table 1. Formulation of Supplement Powder

Treatment	Pea Peel Powder (%)	Jackfruit Seed Powder (%)	Cereal Bran (%)
T1	40	30	30
T2	30	40	30
T3	25	45	30
T4	35	35	30

2.4 Sensory Evaluation

Sensory evaluation of the developed supplement powder formulations was carried out by a semi-trained panel comprising 20 members selected from students and faculty familiar with sensory analysis techniques. The evaluation was conducted under controlled laboratory conditions to minimize bias and ensure consistency. A 9-point hedonic scale was employed to assess the degree of liking, where a score of 1 indicated "dislike extremely" and 9 indicated "like extremely." Each sample was coded and presented randomly to the panelists to avoid any identification bias. The sensory attributes evaluated included colour, taste, texture, aroma, and overall acceptability. Panelists were provided with water to rinse their mouths between samples to prevent flavour carryover. The scores obtained were recorded systematically and used for statistical analysis to determine the most acceptable formulation.

2.5 Proximate Analysis

Proximate composition of the developed supplement powder formulations was determined using standard methods recommended by the **Association of Official Analytical Chemists (AOAC)**. Moisture content was estimated by oven-drying the samples at a controlled temperature until a constant weight was achieved. Crude protein content was determined using the Kjeldahl method, which involves digestion, distillation, and titration to estimate total nitrogen, subsequently converted into protein using an appropriate conversion factor. Crude fat content was analyzed by the Soxhlet extraction method using a suitable organic solvent. Ash content, representing total mineral matter, was determined by incinerating the samples in a muffle furnace at high temperature. Carbohydrate content was calculated by difference, subtracting the sum of moisture, protein, fat, and ash from the total weight. Iron content was quantified using Atomic Absorption Spectroscopy (AAS), ensuring precise measurement of mineral concentration. All analyses were carried out in triplicate to ensure accuracy and reproducibility of results (AOAC, 2019; Ranganna, 2010).

2.6 Statistical Analysis

All experimental data obtained from proximate composition and sensory evaluation were expressed as Mean ± Standard Deviation (SD) to represent the central tendency and variability of the results. Statistical analysis was performed using one-way Analysis of Variance (ANOVA) to determine the presence of significant differences among the different formulations (T1, T2, T3, and T4). This method allowed comparison of multiple group means simultaneously to assess the effect of varying ingredient proportions on nutritional and sensory parameters. A significance level of $p < 0.05$ was considered statistically significant, indicating that the observed differences were unlikely to have occurred by chance. The statistical analysis ensured the reliability and validity of the experimental findings and helped identify the most acceptable and nutritionally superior formulation.

3. Results and Discussion

Table 2. Proximate Composition of Supplement Powder

Parameter (per 100g)	T1	T2	T3	T4
Moisture (%)	6.2 ± 0.2	6.0 ± 0.3	5.8 ± 0.2	6.1 ± 0.2
Protein (g)	15.4 ± 0.4	17.2 ± 0.3	18.6 ± 0.5	16.5 ± 0.4
Fat (g)	3.5 ± 0.2	3.8 ± 0.1	4.0 ± 0.2	3.7 ± 0.2
Ash (g)	5.2 ± 0.3	5.6 ± 0.2	5.9 ± 0.3	5.4 ± 0.2
Carbohydrates (g)	69.7	67.4	65.7	68.3
Iron (mg)	7.1 ± 0.2	8.5 ± 0.3	9.2 ± 0.4	8.0 ± 0.3

The proximate composition results revealed significant variation among the developed formulations, primarily influenced by the proportion of jackfruit seed powder, pea peel powder, and cereal bran. Among all treatments, T3 exhibited the highest protein (18.6 ± 0.5 g/100 g) and iron content (9.2 ± 0.4 mg/100 g), which can be attributed to the higher incorporation of jackfruit seed powder, known for its rich protein and mineral profile. A gradual increase in fat and ash content was also observed in T3, indicating enhanced energy density and mineral availability. Conversely, carbohydrate content showed a decreasing trend with increasing protein levels, suggesting a dilution effect due to higher protein-rich ingredient inclusion. Moisture content across all formulations remained low (5.8–6.2%), indicating good shelf stability. These findings are consistent with previous studies by

Islam et al. (2020), who reported high protein and mineral content in jackfruit seed flour, and by Sharma and Singh (2022), who demonstrated that incorporation of food waste-derived ingredients significantly improves nutritional quality of functional food products. Similarly, a study by Gupta and Prakash (2011) highlighted that plant-based by-products such as peels and bran contribute to increased ash and micronutrient content. Therefore, the present results validate that strategic utilization of food waste materials can effectively enhance the nutritional profile of supplement powders while maintaining desirable compositional balance.

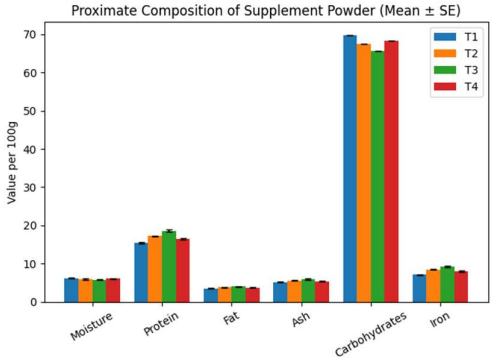

Figure 1. Bar Diagram Showing Proximate Composition of Nutrient-Dense Supplement Powder Formulations (T1–T4) Expressed as Mean ± Standard Error (SE)

Table 3. Sensory Evaluation of Supplement Powder

Attribute	T1	T2	T3	T4
Colour	7.5 ± 0.4	7.8 ± 0.3	8.2 ± 0.2	7.9 ± 0.3
Taste	7.2 ± 0.5	7.6 ± 0.4	8.4 ± 0.3	7.8 ± 0.4
Texture	7.3 ± 0.3	7.7 ± 0.2	8.3 ± 0.2	7.6 ± 0.3
Aroma	7.4 ± 0.3	7.9 ± 0.3	8.5 ± 0.2	7.7 ± 0.3
Overall Accept.	7.3 ± 0.4	7.8 ± 0.3	8.4 ± 0.2	7.7 ± 0.3

The sensory evaluation results demonstrated that all formulations were generally acceptable, with mean scores above 7 on the 9-point hedonic scale; however, formulation T3 consistently achieved the highest scores across all attributes, including colour (8.2 ± 0.2), taste (8.4 ± 0.3), texture (8.3 ± 0.2), aroma (8.5 ± 0.2), and overall acceptability (8.4 ± 0.2). The superior acceptability of T3 may be attributed to the optimal balance between jackfruit seed powder and pea peel powder, which enhanced flavour, aroma, and mouthfeel while minimizing any undesirable bitterness associated with higher peel content. In contrast, T1 showed comparatively lower scores, possibly due to higher inclusion of pea peel powder affecting taste and texture. These findings are in agreement with previous studies, where incorporation of jackfruit seed flour improved sensory properties due to its pleasant nutty flavour and better texture (Islam et al., 2020). Similarly, Sharma and Singh (2022) reported that moderate incorporation of food waste-derived ingredients enhances sensory acceptability, whereas excessive inclusion may negatively impact taste and palatability. Gupta and Prakash (2011) also observed that balancing plant-based by-products is crucial to maintain desirable sensory characteristics. Thus, the present study confirms that appropriate formulation plays a key role in developing acceptable nutrient-dense products from food waste materials.

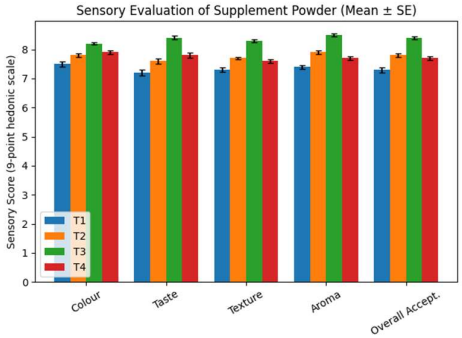

Figure 2. Bar Diagram Representing Sensory Evaluation Scores of Supplement Powder Formulations (T1–T4) for Different Attributes Expressed as Mean ± Standard Error (SE)

Conclusion:

The study successfully developed a nutrient-dense supplement powder utilizing food waste sources such as pea peels, jackfruit seeds, and cereal bran. Among all formulations, T3 exhibited the best nutritional and sensory characteristics, with high protein and iron content and superior acceptability. The developed product offers a sustainable, low-cost solution for addressing malnutrition and reducing food waste. Further research can focus on shelf-life studies and large-scale production.

References:

- AOAC. (2019). *Official Methods of Analysis of AOAC International* (21st ed.). Association of Official Analytical Chemists, Washington, DC.
- Bhutia, D. T. (2014). Protein energy malnutrition in India: the plight of our under five children. *Journal of family medicine and primary care*, *3*(1), 63-67.
- Gupta, S., & Prakash, J. (2011). Nutritional and functional properties of green leafy vegetables. *Journal of Food Science*, 76(5), R94–R103.
- Islam, M. S., Rahman, M. M., & Uddin, M. B. (2020). Nutritional and functional

properties of jackfruit seed flour. *Food Chemistry, 320*, 126–135.

- Liu, Z., De Souza, T. S., Holland, B., Dunshea, F., Barrow, C., & Suleria, H. A. (2023). Valorization of food waste to produce value-added products based on its bioactive compounds. *Processes*, *11*(3), 840.
- Meghwal, M. U. R. L. I. D. H. A. R., Divyashree, K., & Kumar, N. I. T. I. N. (2018). Fruits, vegetables, and grains: their peels and fiber for better human health. *State-Art Technol Food Sci Human Health Emerg Issues Spec Topics*, *3*, 10.
- Ranganna, S. (2010). *Handbook of Analysis and Quality Control for Fruit and Vegetable Products* (2nd ed.). Tata McGraw-Hill Publishing Company Limited, New Delhi.
- Sharma, S., & Singh, B. (2022). Utilization of food waste for development of functional foods: A sustainable approach. *Journal of Nutrition and Food Science, 12*(4), 1–10.
- Wani, N. R., Rather, R. A., Farooq, A., Padder, S. A., Baba, T. R., Sharma, S., ... & Ara, S. (2024). New insights in food security and environmental sustainability through waste food management. *Environmental Science and Pollution Research*, *31*(12), 17835-17857.