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Nutrient Evaluation of an Enteral formula Compounded from Soya Bean (*Glycine max*), Finger Millet (*Eleusine coracana*), and Red Sorghum (*Sorghum bicolor*)

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ABSTRACT

The high cost and limited availability of commercial enteral formulas in resource-poor settings like Nigeria necessitate the development of nutritious, affordable, and locally-sourced alternatives. Soybean, finger millet, and red sorghum are underutilized and locally available crops with exceptional nutritional profiles suitable for compounding enteral feeds for clinical nutrition. This study aimed to formulate and evaluate the nutrient composition of enteral feed powders compounded from blends of soybean, finger millet, and red sorghum. Mixed samples of soybean, finger millet, and red sorghum were purchased from the different markets in Cross River State. Nigeria and processed using various local methods (fermentation, roasting, and sprouting). The processed flours were combined in 30: 70 ratios to create distinct compounded formulations. The proximate composition (moisture, ash, crude protein, fat, dietary fibre, and carbohydrates) and mineral content (Mg, Fe, Ca, Zn, K, Mn, etc.) were determined using standard AOAC methods and Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Data were analyzed using SPSS version 26. Results showed that soybean-based formulations were significantly higher in protein (28.68–34.82%), fat (16.64–23.58%), and dietary fibre (19.01–23.13%), while cereal-based formulations recorded higher carbohydrates (65.74–74.06%). Sprouting significantly enhanced the mineral density of the cereals, particularly calcium in finger millet (406.69 mg/100g) and iron in red sorghum (6.16 mg/100g). The final blended formulations (F1–F6) showed balanced profiles, with protein content ranging from 14.66% to 16.01% and enhanced mineral levels, especially in formulations containing sprouted ingredients. Blending soybean, finger millet, and red sorghum can produce nutritionally rich, cost-effective, and locally sustainable enteral feed powders. These formulations showed a viable alternative to imported commercial products, potentially improving nutrition support in Nigerian hospitals. Future research should focus on bioavailability, sensory evaluation, and shelf-life stability.

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Introduction

Malnutrition among hospitalized patients remains a serious and underdiagnosed clinical challenge, with global prevalence rates estimated between 20% and 50% upon admission (Pierzak *et al.,* 2020; Munguti *et al.,* 2024). This condition is not just a common comorbidity but a critical determinant of patient outcomes, directly leading to impaired immune function, increased infection rates, delayed wound healing, prolonged hospitalization, and elevated mortality. In resource-limited settings, the economic burden associated with these complications affects the healthcare systems that is already weak. However, the provision of adequate and timely nutrition support is a fundamental component of effective clinical care and is integral to recovery. Enteral nutrition (EN), the delivery of nutrient formulas directly into the gastrointestinal tract, is the standard of care for patients with a functional gut who cannot meet their nutritional needs orally (Bechtold *et al.,* 2022). It is strongly preferred over parenteral nutrition due to its role in preserving gut mucosal integrity, supporting immune function, and reducing septic complications (Doley, 2022). However, in resource-limited settings like Nigeria, the reliance on expensive, imported commercial formulas creates a critical barrier to access. This situation forces many healthcare facilities and caregivers to depend on non-standardized, blenderized homemade feeds, which usually lacks nutritional adequacy, pose microbial contamination risks, and result in poor patient tolerance (Putri *et al.,* 2025; Adom, 2020). This study, conducted from December 2024 to August 2025 in Calabar, Cross River State, Nigeria, was therefore designed to address this gap by developing sustainable, cost-effective, and nutritious enteral feed powders from a blend of locally available grains such as soybean (*Glycine max*), finger millet (*Eleusine coracana*), and red sorghum (*Sorghum bicolor*).

These crops were selected for their complementary and exceptional nutritional profiles. Soybean is renowned as a high-quality protein source (36-40%) rich in all essential amino acids, lipids, and minerals such as iron and magnesium (Siddique *et al.,* 2024; Modgil *et al.,* 2020). Finger millet, a gluten-free "nutricereal," is exceptionally high in calcium surpassing most other cereals and dietary fibre, offering benefits for bone health and glycaemic control (Asrani *et al.,* 2023; Patil *et al.,* 2023). Red sorghum provides energy-dense complex carbohydrates, and is rich in antioxidants like tannins and anthocyanins, and contributes dietary fibre (Awika & Rooney, 2024). While some studies have explored these crops in isolation, their combined potential for developing specialized, scientifically-validated enteral feeding formulas remains largely unexplored. Therefore, the study aimed to formulate enteral tube feed powders from optimized blends of soybean, finger millet, and red sorghum, and conduct a comprehensive evaluation of their proximate and mineral composition to establish their nutritional adequacy and potential as viable, sustainable alternatives to costly commercial products.

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Materials and Methods

Research Design, Location, and Duration

A cross sectional experimental research design was employed to formulate and analyze enteral feed powders. The study was conducted in Calabar, Cross River State. Nigeria. The sample collection, processing, and laboratory analysis took place between December 2024 and August 2025.

Sample Collection and Preparation

Soybean (*Glycine max*), finger millet (*Eleusine coracana*), and red sorghum (*Sorghum bicolor*) were purchased from local markets (Marian Market, Gbogobri Market, and Watt Market) in Calabar, Cross River State. Nigeria. A market survey was first conducted to identify all the vendors selling the grains in these markets. The mixed quantity of each grains used was purchased from the entire vendor using the local measuring cups; Soybeans (5.730 kg from 12 vendors), Red sorghum (4.6 kg from 21 vendors) and Finger millet (4.5 kg from 3 vendors).

Processing of Raw Materials

The raw materials comprising soybeans, finger millet, and red sorghum were thoroughly cleaned to remove foreign particles, stones, and damaged grains, followed by careful sorting to ensure only wholesome materials were processed.

Table 1. Processing of Soybeans

Ingredients	Method Code	Processing Methods
Soya bean – raw	Method 1 (M1)	The mixed soybeans grains from the different vendors were thoroughly cleaned to remove foreign particles, stones, and damaged grains, followed by careful sorting to ensure only wholesome grains were milled in batches using Goldenwall High-speed Multifunction Grinder at rotation speed of 28000 r/min for 2.5mins. per milling batch.
Soya bean – Method 1 Whole	Method 2 (M2)	The mixed grains were sorted, completely submerged in distilled water and soaked for 12 hours at room temperature (of 21°C). After soaking, it was drained and transferred into a boiling water, and allowed to boiled for 20mins. It was then drained and refreshed using distilled water and allowed to drain for 20mins. After lagged drained time, the grains were then pan fried with Deik Aluminum Frypan with Nonstick Coating (product No: SD-DFPB-28) and stirred continuously over medium heat hot plate using bamboo spatula until completely dried and golden brown. The golden brown pan-fried hot grains were then poured into a stainless-steel colander for it cool down before milling it in batches using Goldenwall High-speed Multifunction Grinder at rotation speed of 28000 r/min for 2.5mins. per milling batch.
Soya bean – Method 1 Debran	Method 4 (M4)	The mixed grains were sorted, completely submerged in distilled water and soaked for 12 hours at room temperature (of 21°C). After soaking, it was drained and transferred into a boiling water, and allowed to boiled for 20mins. It was then drained, refreshed, debran and rinsed, using distilled water and allowed to drain for 20mins. After lagged drained time, the grains were then pan fried with Deik Aluminum Frypan with Nonstick Coating (product No: SD-DFPB-28) and stirred continuously over medium heat hot plate using bamboo spatula until completely dried and golden brown. The golden brown pan-fried hot grains were then poured into a stainless-steel colander for it cool down before milling it in batches using

		Golden wall High-speed Multifunction Grinder at rotation speed of 28000 r/min for 2.5mins. per milling batch.
Soya bean – Method 2 Whole	Method 3 (M3)	The mixed grains were sorted, completely submerged in distilled water and allowed to ferment by its microflora at a temperature of 21°C for 72 hours. After the lagged time, it was drained, rinsed and drained again with distilled water; transferred and held at -80°C for 1hour before transferring it to the Lablyo freeze dryer, were it was freeze dried at -50°C (sample temperature), -52.7°C (cold trap temperature) and 00008pa (vacuum pressure) for 48hours. The dried grains were then milled in batches using Goldenwall High-speed Multifunction Grinder at rotation speed of 28000 r/min for 2.5mins. per milling batch.
Soya bean – Method 2 Debran	Method 5 (M5)	The mixed grains were sorted, completely submerged in distilled water and allowed to ferment by its microflora at a temperature of 21°C for 72 hours. After the lagged time, it was drained, debran, rinsed with distilled water, drained, transferred and held at -80°C for 1hour before transferring it to the Lablyo freeze dryer, were it was freeze dried at -50°C (sample temperature), -52.7°C (cold trap temperature) and 00008pa (vacuum pressure) for 48hours. The dried grains were then milled in batches using Goldenwall High-speed Multifunction Grinder at rotation speed of 28000 r/min for 2.5mins. per milling batch.

Table 2. Processing of Finger Millet

Ingredients	Method Code	Processing Methods
Finger Millet (Tamba) -72hrs. Fermentation	Method 1 (M1)	The grains were sorted, completely submerged in distilled water and allowed to ferment by its own microflora at a temperature of 21°C for 48 hours in a BioMat2 (class 2 Microbiological Safety Cabinet Complies with BS EN 12469:2000) sterile cabinet. After the lagged time, it was drained, rise and drained again with distilled water. The grains were then transferred and held at -80°C for 1hour before transferring it to the Lablyo freeze dryer, where it was freeze dried at -50°C (sample temperature), -52.7°C (cold trap temperature) and 00008pa (vacuum pressure) for 48hours. The grains were then milled in batches using Goldenwall High-speed Multifunction Grinder at rotation speed of 28000 r/min for 2.5mins. each
Finger Millet (Tamba) raw	Method 2 (M2)	The mixed soybeans grains from the different vendors were thoroughly cleaned to remove foreign particles, stones, and damaged grains, followed by careful sorting to ensure only wholesome grains were milled in batches using Goldenwall High-speed Multifunction Grinder at rotation speed of 28000 r/min for 2.5mins. per milling batch.
Finger Millet (Tamba) – sprouted	Method 3 (M3)	The grains were sorted, completely submerged in distilled water and soaked for 12 hours at a temperature of 21°C in a BioMat2 (class 2 Microbiological Safety Cabinet Complies with BS EN 12469:2000) sterile cabinet. After the 12 hours soaking time, the grains were drained, spread on oven tray, and kept in Memmert oven for 48 hours at 35°C and air flow of 5 for the grains to sprout. The grains were then removed from the oven, rinsed with distilled water, drained with a fine sieve, transferred and held at -80°C for 1hour before transferring it to the Lablyo freeze dryer, where it was freeze dried

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		at -50°C (sample temperature), -52.7°C (cold trap temperature) and 00008pa (vacuum pressure) for 48hours. The grains were then milled in batches using Goldenwall High-speed Multifunction Grinder at rotation speed of 28000 r/min for 2.5mins. each.

Table 3. Processing of Red sorghum.

Ingredients	Method Code	Processing Methods
Red Guinea corn/Red Sorghum - 72hrs – Fermentation	Method 1 (M1)	The grains were sorted, completely submerged in distilled water and allowed to ferment by its own microflora at a temperature of 21°C for 48 hours in a BioMat2 (class 2 Microbiological Safety Cabinet Complies with BS EN 12469:2000) sterile cabinet. After the lagged time, it was drained, rise and drained again with distilled water. The grains was then transferred and held at -80°C for 1hour before transferring it to the Lablyo freeze dryer, were it was freeze dried at -50°C (sample temperature), -52.7°C (cold trap temperature) and 00008pa (vacuum pressure) for 48hours. The grains were then milled in batches using Goldenwall High-speed Multifunction Grinder at rotation speed of 28000 r/min for 2.5mins. per milling batch.
Red Guinea corn/Red Sorghum – raw	Method 2 (M2)	The mixed Red Guinea corn/Red Sorghum grains from the different vendors were thoroughly cleaned to remove foreign particles, stones, and damaged grains, followed by careful sorting to ensure only wholesome grains were milled in batches using Goldenwall High-speed Multifunction Grinder at rotation speed of 28000 r/min for 2.5mins. per milling batch.
Red Guinea corn/Red Sorghum – Sprouted	Method 3 (M3)	The grains were sorted, completely submerged in distilled water and soaked for 12 hours at a temperature of 21°C in a BioMat2 (class 2 Microbiological Safety Cabinet Complies with BS EN 12469:2000) sterile cabinet. After the 12 hours soaking time, the grains were drained, spread on oven tray, and kept in Memmert oven for 48 hours at 35°C and air flow of 5 for the grains to sprout. The grains were then removed from the oven, rinsed with distilled water, drained with a fine sieve, transferred and held at -80°C for 1hour before transferring it to the Lablyo freeze dryer, where it was freeze dried at -50°C (sample temperature), -52.7°C (cold trap temperature) and 00008pa (vacuum pressure) for 48hours. The grains were then milled in batches using Goldenwall High-speed Multifunction Grinder at rotation speed of 28000 r/min for 2.5mins. per milling batch.

Table 4. Processing Methods and Outcomes

Methods	Grains	After Purchase (g)	After Sorting (g)	After Treatment (g)	After Milling (g)	Final Sample Weight (g)
Soya bean - Method 2 Whole (Method 3)	Soybeans	1000	950	792	650	650
Soya bean - Method 2 Debran (Method 5)	Soybeans	1000	950	800	600	600

Soya bean - Method 1 Debran (Method 4)	Soybeans	1000	950	900	650	650
Soya bean - Method 1 Whole (Method 2)	Soybeans	1730	1703	1482	1467	1467
Soya bean – raw (Method 1)	Soybeans	1000	950	842	751	391
Tamba -72hrs. (Method 1)	Finger Millet	1750	1703	1510	1428	1148
Tamba raw (Method 2)	Finger Millet	980	950	798	747	467
Tamba – sprouded (Method 3)	Finger Millet	1770	1703	1675	1450	1170
Red Guinea corn - 72hrs. (Method 1)	Red Sorghum	1530	1520	1500	1500	1220
Red Guinea corn – raw (Method 2)	Red Sorghum	1530	1520	1500	1400	1120
Red Guinea corn – sprouted (Method 3)	Red Sorghum	1540	1530	1500	1500	1220

Formulation of Enteral Feed Powders

Following the processing of soybean, finger millet, and red sorghum, the resultant flours were blended to produce three distinct enteral feed formulations in line with the study objective of developing sustainable enteral tube feed powders. The formulations were prepared using a standardized mixing ratio of 30:70 (legume to cereal), where soybean served as the protein-rich legume component and finger millet or red sorghum served as the carbohydrate-rich cereal component.

For each formulation, 120 g of soybean flour and 280 g of cereal flour were accurately weighed to yield a total of 400 g per formulation. The powders were thoroughly mixed using a mechanical laboratory blender until a uniform and homogeneous blend was achieved. Each formulation was then appropriately coded and stored in clean, airtight containers to prevent moisture absorption and contamination prior to proximate and nutrient evaluation. The variations among the formulations were based on the different processing methods applied to the cereal component, as presented in Table 2, while maintaining a constant soybean processing methods and fixed formulation ratio.

Table 5: Feed Compounding Using Soybean, Finger Millet And Red Sorghum

Formulation	Formulation Composition	Mixture Ratio	Soybean Powder (g)	Sorghum Powder (g)	Total (g)
F1	Soybean M2 + Sorghum M1	30:70	120	280	400
F2	Soybean M2 + Sorghum M2	30:70	120	280	400

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F3	Soybean M2 + Sorghum M3	30:70	120	280	400
F4	Soybean M2 + Finger Millet M1	30:70	120	280	400
F5	Soybean M2 + Finger Millet M2	30:70	120	280	400
F6	Soybean M2 + Finger Millet M3	30:70	120	280	400

M1 – Method 1; M2 – Method 2; M3 – Method 3; F1 – Formulation 1, F2 – Formulation 2, F3 – Formulation 3, F4 – Formulation 4, F5 – Formulation 5, and F6 – Formulation 6

Proximate Composition Analysis

Standard analytical procedures of the Association of Official Analytical Chemists (AOAC, 2019) were used for the proximate analysis. All analyses were performed in triplicate.

Moisture Content

This was determined by the gravimetric method. Approximately 2g of sample (W2) was weighed into a pre-weighed, dried porcelain crucible (W1) and dried in a thermostatically controlled oven (Gallenkamp Size One Oven -BS) at 100 ± 5°C for 5 hours. The crucible was then transferred to a desiccator, cooled, and reweighed (W3). Moisture content was calculated as: [(W2 - (W3 - W1)) / W2] x 100.

Ash Content

The method involved incinerating approximately 2g of sample in a pre-weashed porcelain crucible using a muffle furnace (Ney Volcan 3-550) at 500±50°C for 12 hours until a white ash was obtained. The ash content was calculated from the weight of the residue.

Crude Protein

This was determined by the Kjeldahl method. A 0.5g sample was digested with sulfuric acid and a catalyst tablet in a VELP Scientifica DK Heating Digester. The nitrogen content was automatically distilled and titrated using a UDK 169 Automatic Distillation and Titration System. Crude protein was calculated as % Nitrogen x 6.25.

Total Fat

The fat content was determined by acid hydrolysis followed by Soxhlet extraction (AOAC 991.39). A 6g sample was hydrolyzed with 4N HCl in a VELP Scientifica HU 6 Hydrolysis Unit. The residue was filtered, dried, and extracted with hexane using a VELP Scientifica SER 148 Solvent Extractor. The fat content was calculated from the weight of the extract.

Dietary Fibre

This was determined based on AACC (2010) Method 32-05.01 and AOAC 985.29 using a Megazyme Total Dietary Fibre Kit. The enzymatic-gravimetric method involved sequential digestion with heat-stable α-amylase, protease, and amyloglucosidase.

Carbohydrate

The carbohydrate content was calculated by difference: % Carbohydrate = 100% - (% Moisture + % Ash + % Crude Protein + % Fat + % Dietary Fibre).

Mineral Analysis

The mineral composition was determined using Inductively Coupled Plasma Mass Spectrometry (ICP-MS). A 1000μg sample was digested with nitric acid (HNO_3) and hydrogen peroxide (H_2O_2) using a CEM Microwave Digester (MARS One Touch Technology). The digest was stabilized with a rhodium standard and analyzed using a ThermoScientific ICP-MS (iCAP TQ). The minerals analyzed included Magnesium (Mg), Iron (Fe), Calcium (Ca), Copper (Cu), Phosphorus (P), Zinc (Zn), Potassium (K), Manganese (Mn), Sodium (Na), Aluminium (Al), and Boron (B).

Data Analysis

Data generated from the proximate and mineral analyses were statistically analyzed using SPSS software (Version 26). Mean values and standard deviations were computed from triplicate determinations. A one-way analysis of variance (ANOVA) was employed to determine significant differences among the various formulations. Where significant differences existed, a post-hoc test was conducted. A p-value of less than 0.05 was considered statistically significant.

Results and Discussion

Proximate Composition of the Different Procesing Methods of Enteral Feed Compounded from Soybeans, Finger Millet and Red Sorghum

The proximate composition of the enteral tube feed powders compounded from soybeans, finger millet and red sorghum is presented in Table 3. Moisture content was highest ($p < 0.05$) in Sorghum M2 (11.82 ± 0.37) compared to all other formulations, while Soybean M5 recorded the lowest moisture content (6.64 ± 0.15). The reduced moisture content in soybean M5 and Sorghum M1 formulations suggests enhanced storage stability and reduced microbial susceptibility, which is desirable for powdered enteral feeds. This aligns with findings of Kamau et al. (2018) who reported that lower moisture content significantly improves shelf-life and product safety in tropical environments. Ash content was significantly higher ($p < 0.05$) in soybean formulations (3.57 ± 0.11– 5.07 ± 0.10) compared to finger millet (2.40 ± 0.17 – 2.71 ± 0.11) and sorghum (1.23 ± 0.05 – 1.53 ± 0.04) formulations. The higher ash content shows the superior mineral contribution of soybean, supporting its value as a mineral-dense component in composite enteral feeds. This aligns with the findings of Zewudie & Gemede. (2024) who reported higher ash content in soybean-based therapeutic formulations due to their enhanced calcium, magnesium, and phosphorus composition. Dietary fibre content was highest ($p < 0.05$) in soybean methods (19.01 ± 0.13 – 23.13 ± 0.14) compared to finger millet (10.09 ± 0.26 – 12.58 ± 0.30) and sorghum (7.78 ± 0.09 – 8.26 ± 0.10) formulations.

The high fibre content of soybean-based formulations indicates improved potential for bowel regulation and gastrointestinal functionality in enterally fed patients. This is consistent with the findings of Kaewdech et al. (2022) who reported that fibre-enriched enteral feeds significantly improve stool consistency and reduce gastrointestinal complications. However, the high fibre content may also reduce mineral bioavailability, representing a potential limitation in nutrient utilisation that should be considered clinically (Holodová *et al.,* 2019). Crude protein content was also highest ($p < 0.05$) in soybean formulations (28.68 ± 0.30 – 34.82 ± 1.03) compared to finger millet (6.49 ± 0.28 – 7.13 ± 0.14) and sorghum (6.72 ± 0.50 – 8.43 ± 0.41) formulations. This confirms soybean as the primary protein contributor in the composite feed. This supports the findings of Zhang et al. (2020) who reported that soybean incorporation significantly enhances protein density and improves nitrogen balance in plant-based enteral nutrition systems, thereby supporting tissue repair and metabolic recovery. However, fat content was also highest ($p < 0.05$) in soybean methods (16.64 ± 0.28 – 23.58 ± 0.03) compared to the very low-fat levels in finger millet (1.12 ± 0.03 – 1.32 ± 0.07) and sorghum (2.04 ± 0.16 – 2.29 ± 0.05) methods. The higher

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lipid content of soybean formulations contributes to increased energy density, which is beneficial for patients with elevated caloric demands or reduced feeding tolerance. Carbohydrate recorded higher values ($p < 0.05$) in sorghum formulations (70.03 ± 0.36 – 74.06 ± 0.10) compared to finger millet (65.74 ± 0.12 – 68.82 ± 0.51), while soybean formulations recorded significantly lower carbohydrate values (12.19 ± 0.44 – 17.29 ± 1.18). This confirms cereals as the primary energy-providing components of the formulation, a finding consistent with Temba et al. (2016) that identified sorghum and millet as dominant carbohydrate sources in composite therapeutic feeds.

One key limitation of this study is the absence of evaluation of anti-nutritional factors and nutrient bioavailability, which may influence actual nutrient utilisation despite statistically significant compositional differences. This shows the need for further studies incorporating bioavailability and micronutrient response profiles. From a practical perspective, the formulation has strong suitability as a nutritionally adequate and cost-effective alternative to commercial enteral feeds. The high protein and energy contribution of soybean-based blends supports their application in the management of malnutrition, post-surgical recovery, and chronic disease conditions, particularly within low-resource healthcare settings.

Table 6: Proximate Composition of Different Processing Methods of Enteral Feed Formulation from Soya Bean, Finger Millet, and Sorghum (g/100 g dry weight basis)

Sample	**Moisture (%)**	**Ash (%)**	**Dietary Fibre (%)**	**Crude Protein (%)**	**Fat (%)**	**CHO (%)**
Soybean M1	9.51 ± 0.32^{a}	5.07 ± 0.10^{a}	22.27 ± 0.25^{a}	29.21 ± 0.98^{a}	16.64 ± 0.28^{a}	17.29 ± 1.18^{a}
Soybean M2	7.88 ± 0.34^{b}	4.49 ± 0.03^{a}	22.04 ± 0.25^{a}	33.71 ± 0.45^{b}	18.98 ± 0.37^{a}	12.90 ± 0.26^{b}
Soybean M3	7.27 ± 0.08^{b}	4.37 ± 0.22^{a}	23.13 ± 0.14^{a}	28.68 ± 0.30^{a}	21.43 ± 0.13^{b}	15.12 ± 0.23^{c}
Soybean M4	7.51 ± 0.29^{b}	3.57 ± 0.11^{a}	20.32 ± 0.05^{b}	34.82 ± 1.03^{b}	21.58 ± 0.70^{b}	12.19 ± 0.44^{b}
Soybean M5	6.64 ± 0.15^{c}	4.23 ± 0.14^{a}	19.01 ± 0.13^{b}	30.37 ± 1.47^{c}	23.58 ± 0.03^{b}	16.17 ± 1.24^{a}
Finger Millet M1	10.45 ± 0.02^{d}	2.40 ± 0.17^{b}	12.41 ± 0.39^{c}	6.73 ± 0.06^{d}	1.32 ± 0.07^{c}	66.69 ± 0.25^{d}
Finger Millet M2	10.77 ± 0.17^{e}	2.71 ± 0.11^{b}	10.09 ± 0.26^{d}	6.49 ± 0.28^{d}	1.12 ± 0.03^{c}	68.82 ± 0.51^{e}
Finger Millet M3	10.73 ± 0.06^{e}	2.57 ± 0.05^{a}	12.58 ± 0.30^{c}	7.13 ± 0.14^{e}	1.25 ± 0.10^{c}	65.74 ± 0.12^{d}
Sorghum M1	6.84 ± 0.13^{c}	1.23 ± 0.05^{c}	8.11 ± 0.19^{e}	7.46 ± 0.22^{e}	2.29 ± 0.05d	74.06 ± 0.10^{f}
Sorghum M2	11.82 ± 0.37^{f}	1.53 ± 0.04^{d}	7.78 ± 0.09^{e}	6.72 ± 0.50^{d}	2.06 ± 0.05^{e}	70.10 ± 0.86^{g}

Sorghum M3	9.94 ± 0.11^{a}	1.30 ± 0.06^{c}	8.26 ± 0.10^{c}	8.43 ± 0.41^{c}	2.04 ± 0.16^{c}	70.03 ± 0.36^{g}

Values are mean ± standard deviation. Means within the same column with different superscripts differ significantly ($p < 0.05$). M1, M2, M3, M4, M5 = Method 1, 2, 3, 4 and 5

Proximate Composition of the Final Enteral Feed Compounded from Soya Bean, Finger Millet, and Sorghum

The proximate composition of the final enteral feed formulations (F1-F6) is presented in Table 4. Among the six formulations (F1-F6), F2 recorded the highest ($p < 0.05$) moisture content (10.64 ± 0.36), while F1 recorded the lowest (7.15 ± 0.09). F3, F4, F5, and F6 recorded moisture levels below 10%. The lower moisture content is essential for the shelf-stability of powdered food products, as it minimizes the risk of microbial spoilage and chemical deterioration in storage conditions. This aligns with the findings of Zambrano et al. (2019), who emphasized that moisture content below 10% is a key quality indicator for the safe storage of cereal-legume-based food powders in tropical conditions. Ash content was highest ($p < 0.05$) in formulations F4 - F6 (3.03 ± 0.12% to 3.24 ± 0.08%) compared to formulations F1- F3 (2.21 ± 0.03% to 2.42 ± 0.04%). This indicates a higher concentration of mineral components in the F4–F6 formulations. This finding aligns with the work of Jinda et al. (2023), who reported that the strategic combination of cereals and pulses in food formulations can significantly boost the mineral density of the final product, leveraging the innate mineral profile of legumes like soybean. Dietary Fibre content was significantly highest ($p < 0.05$) in F5 (15.30 ± 0.34%) and F6 (15.41 ± 0.20%), classifying them as fibre-enriched formulas.

The inclusion of dietary fibre in enteral nutrition is a critical advancement for managing gastrointestinal complications. This is consistent with the recommendations of Cederholm et al. (2017) in their ESPEN guidelines on clinical nutrition, which highlight that fibre-enriched enteral formulas are effective in normalizing bowel function and supporting gut health in tube-fed patients. Crude Protein content across all formulations (14.66 ± 0.23% to 16.01 ± 0.34%) was substantially elevated compared to the raw cereals, confirming the successful integration of soybean. This finding aligns with the principle of cereal-pulse complementarity, a well-established strategy for improving protein quality in plant-based foods, as detailed by Awika et al. (2017). The protein levels achieved are comparable with those of many commercial polymeric enteral formulas, making them suitable for meeting the protein requirements of a majority of patients. Fat content recorded consistent values across all the formulations, showing no large significant differences. This indicates a controlled and reproducible blending process. The moderate fat level contributes essential fatty acids and supports the energy density of the formulas, which is important for meeting the caloric needs of patients without overburdening lipid metabolism. The carbohydrate values ranged between 49.89 to 55.78% across all the formulations showing a successfully shifted focus toward improving more beneficial nutrients, such as fibre and minerals, resulting in a balanced and healthier nutritional profile. This strategic formulation is consistent with the approach recommended for developing specialized nutritional supports for patients with specific needs, such as those requiring better glycemic control or enhanced micronutrient intake.

The significant differences in the six formulations confirm that the nutritional profile of enteral feeds can be precisely tailored. Formulations F4 - F6, in particular, showed a successful model of cereal-legume synergy, providing enhanced fibre and minerals. This offers practical, cost-effective options for clinical settings, for instance, F5 or F6 could be selected for patients requiring bowel management, while F3 provides a higher protein option. While previous works like those of Singh et al. (2017) on sorghum and millet utilization have highlighted the potential of single grains, this research provides novel data on their synergistic combination with soybean to create multiple, tailored therapeutic products. It strengthens the evidence base for decentralized, sustainable, and culturally appropriate enteral feeding solutions, directly addressing food and health security challenges in developing nations.

Table 7: Proximate Composition of Final Enteral Feed (F1 -F6) Compounded from Soya bean, Finger Millet and Sorghum (g/100 g dry weight basis)

Sample	Moisture (%)	Ash (%)	Dietary Fibre (%)	Crude Protein (%)	Fat (%)	CHO (%)
F1	7.15 ± 0.09^{a}	2.21 ± 0.03^{a}	12.29 ± 0.20^{a}	15.34 ± 0.29^{a}	7.29 ± 0.11^{a}	55.71 ± 0.03^{a}
F2	10.64 ± 0.36^{b}	2.42 ± 0.04^{b}	12.05 ± 0.13^{a}	14.81 ± 0.46^{b}	7.13 ± 0.08^{a}	52.94 ± 0.64^{b}
F3	9.32 ± 0.16^{c}	2.26 ± 0.04^{a}	12.39 ± 0.06^{a}	16.01 ± 0.34^{a}	7.12 ± 0.02^{a}	52.89 ± 0.29^{b}
F4	9.91 ± 0.04^{c}	3.24 ± 0.08^{c}	13.67 ± 0.24^{b}	14.66 ± 0.23^{b}	6.48 ± 0.13^{b}	52.04 ± 0.30^{b}
F5	9.68 ± 0.09^{c}	3.03 ± 0.12^{d}	15.30 ± 0.34^{c}	14.82 ± 0.14^{b}	6.62 ± 0.16^{a}	50.55 ± 0.10^{c}
F6	9.87 ± 0.14^{c}	3.15 ± 0.03^{cd}	15.41 ± 0.20^{c}	15.10 ± 0.19^{a}	6.57 ± 0.11^{b}	49.89 ± 0.08^{c}

Values are mean ± standard deviation (n = 3). Means within the same column with different superscripts (a–c) differ significantly ($p < 0.05$). F 1 – F6: Formulations 1, 2, 3, 4, 5, and 6

Mineral Composition of Different Processing Methods of Enteral Feed Compounded from Soya Bean, Finger Millet, Sorghum (mg/100 g dry weight basis)

Table 5 shows the mineral composition of soybean, finger millet, and red sorghum subjected to different processing methods. Soybean (M1) recorded the highest ($p < 0.05$) levels of magnesium (217.80 mg/100 g), iron (8.60 mg/100 g), phosphorus (473.23 mg/100 g), potassium (1647.51 mg/100 g), and boron (3.21 mg/100 g). These values decreased in the Soybean (M4), which recorded the lowest ($p < 0.05$) Mg (177.43 mg/100 g), Fe (3.54 mg/100 g), K (1026.52 mg/100 g), and Al (0.96 mg/100 g). The reductions reflect the well-documented leaching of water-soluble minerals during prolonged soaking and hull removal (Chauhan *et al.,* 2022; Ouédraogo *et al.,* 2022). Chauhan et al. (2022) findings reported sharp declines in Fe, Mg, and K after hydration or dehulling due to diffusion into soaking water. Calcium levels did not differ significantly ($p > 0.05$) among soybean methods (232–256 mg/100 g), confirming that Ca remains relatively stable during wet processing (Ouédraogo *et al.,* 2022). Zinc also recorded no significant variation ($p > 0.05$) across all soybean treatments (3.11–

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4.02 mg/100 g). The highest copper level was recorded in soybean (M5), significantly higher ($p < 0.05$) than all other methods. This increase may reflect concentration effects following hull removal and drying (Chauhan *et al.,* 2022). Sodium increased significantly ($p < 0.05$) in M2 and M4 (22–24 mg/100 g), likely due to mineral concentration post-processing (Ouédraogo *et al.,* 2022).

In the finger millet samples, calcium retained its characteristic high calcium content across all the methods, with finger millet (M2) recording the significantly highest value ($p < 0.05$; 503.29 mg/100 g). The increase in Ca following sprouting agrees with reports that germination enhances Ca concentration through reduced dry-matter mass and improved mineral liberation (Dhliwayo *et al.,* 2023; Kumar *et al.,* 2021). Calcium was lowest ($p < 0.05$) in finger millet (M1), reflecting minor leaching into soaking media (Abioye *et al.,* 2022). Phosphorus ranged from 225–286 mg/100 g, with soaked millet (M1) presenting the significantly lowest value ($p < 0.05$), aligning with observed P losses during steeping (Abioye *et al.,* 2022). Magnesium levels remained statistically similar ($p > 0.05$) among all finger millet samples (Abioye et al., 2022). However, iron recorded the highest value ($p < 0.05$) in raw millet (M2), with a significant reduction after sprouting ($p < 0.05$), consistent with Fe redistribution during germination (Dhliwayo *et al.,* 2023; Kumar *et al.,* 2021). Finger millet also contained exceptionally high manganese levels, with M3 (32.65 mg/100 g) significantly highest ($p < 0.05$), aligning with its known nutritive signature as a rich Mn source (Abioye *et al.,* 2022).

All sorghum samples recorded very low calcium content (9–10 mg/100 g), consistent with earlier findings (Iyabo *et al.,* 2020; Keyata *et al.,* 2021). Sorghum (M3) recorded significant increases ($p < 0.05$) in magnesium, phosphorus, potassium, and manganese, supporting findings of Davana et al. (2021) that germination enhances mineral mobilization as enzymes degrade cell walls and release bound nutrients. Iron was significantly highest ($p < 0.05$) in sorghum M3 (6.16 mg/100 g), while sorghum (M2) recorded lower values (3.62 mg/100 g), agreeing with improved Fe bioavailability during sprouting due to phytate breakdown (Kayisoglu *et al.,* 2024; Davana *et al.,* 2021). Sodium and boron remained low across all samples, and no significant difference ($p > 0.05$) was observed for aluminum.

These findings highlight the mineral-specific sensitivity of grains to different processing methods and shows that germination is the most effective technique for enhancing mineral concentration and availability (Dhliwayo *et al.,* 2023; Kumar *et al.,* 2021; Kayisoglu *et al.,* 2024; Davana *et al.,* 2021). Practically, sprouted finger millet and sprouted sorghum (M3) were superior mineral sources suitable for nutrient-dense enteral tube-feeding formulations. Debranned soybean (M5) showed enhanced trace mineral levels and may serve as a valuable ingredient for formulations requiring higher Zn and Cu

With the comprehensive evaluation this study has provided, multiple standard household processing techniques influence the mineral composition of key African grains. The combined, comparative assessment across soybean, finger millet, and sorghum fills a notable research gap, offering practical evidence relevant to food formulation and clinical nutrition. The findings contribute to improved understanding of processing–nutrient interactions and provide a data-driven basis for optimizing enteral feeding powders using locally available grains.

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Table 8: Mineral Composition of Different Processing Methods of Enteral Feed Compounded from Soya Bean, Finger Millet, and Sorghum (mg/100 g dry weight basis)

Sample	**Mg**	**Fe**	**Ca**	**Cu**	**P**	**Zn**	**K**	**Mn**	**Na**	**Al**	**B**
Soybean M1	217.80 ± 14.54^{a}	8.60 ± 0.04^{a}	234.51 ± 5.37^{a}	1.08 ± 0.01^{a}	473.23 ± 19.07^{a}	3.74 ± 0.19^{a}	1647.51 ± 12.99^{a}	2.33 ± 0.04^{a}	2.51 ± 0.28^{a}	11.92 ± 0.08a	3.21 ± 0.01^{a}
Soybean M2	211.67 ± 7.55^{a}	5.01 ± 0.15^{b}	255.73 ± 6.00^{a}	1.11 ± 0.00^{a}	492.01 ± 7.07^{a}	3.33 ± 0.06^{a}	1506.73 ± 6.44^{b}	2.36 ± 0.04^{a}	24.18 ± 9.79^{b}	1.66 ± 0.03^{b}	2.53 ± 0.10^{a}
Soybean M3	207.00 ± 14.80^{a}	5.97 ± 0.30^{b}	232.29 ± 6.60^{a}	1.08 ± 0.01^{a}	465.96 ±17.76^{a}	3.59 ± 0.22^{a}	1444.40 ± 46.01^{b}	2.34 ± 0.09^{a}	5.74 ± 0.17^{c}	3.44 ± 0.09^{b}	2.94 ± 0.13^{a}
Soybean M4	177.43 ± 1.93^{b}	3.54 ± 0.07^{c}	243.96 ± 4.87^{a}	1.07 ± 0.02^{a}	451.36 ± 14.59^{a}	3.11 ± 0.10^{a}	1026.52 ± 20.09^{c}	2.42 ± 0.06^{a}	22.08 ± 1.83^{b}	0.96 ± 0.02^{c}	2.45 ± 0.06^{a}
Soybean M5	197.57 ± 16.15^{c}	5.32 ± 0.09^{b}	240.43 ± 0.20^{a}	1.83 ± 0.01^{b}	457.03 ± 2.93^{a}	4.02 ± 0.06^{a}	1156.07 ± 14.02^{c}	2.38 ± 0.18^{a}	14.12 ± 0.11^{d}	3.74 ± 0.09^{b}	2.74 ± 0.05^{a}
Finger Millet M1	136.60 ± 0.53^{d}	3.34 ± 0.09^{c}	377.49 ± 9.04^{c}	0.61 ± 0.01^{c}	225.84 ± 3.36^{b}	1.94 ± 0.03^{b}	325.91 ± 8.40^{d}	25.34 ± 0.25^{b}	3.41 ± 0.06^{c}	3.88 ± 0.10^{b}	0.41 ± 0.01^{b}
Finger Millet M2	136.57 ± 6.35^{d}	4.53 ± 0.43^{b}	503.29 ± 11.28^{b}	0.90 ± 0.15^{a}	286.92 ± 9.83^{c}	2.38 ± 0.23^{b}	427.04 ± 20.91^{e}	32.65 ± 0.25^{a}	2.65 ± 0.03^{a}	5.45 ± 0.07^{a}	1.14 ± 0.05^{b}
Finger Millet M3	146.64 ± 3.73^{e}	2.63 ± 0.06^{d}	406.69 ± 15.44^{c}	0.74 ± 0.04^{c}	236.79 ± 1.75^{b}	2.25 ± 0.11^{b}	359.80 ± 7.38^{d}	27.92 ± 0.76^{b}	3.05 ± 0.10^{c}	3.10 ± 0.08^{b}	0.72 ± 0.02^{b}
Sorghum M1	131.57 ± 2.53^{d}	5.07 ± 0.02^{b}	9.68 ± 0.18^{d}	0.46 ± 0.00^{d}	219.02 ± 3.33^{b}	2.46 ± 0.01^{b}	272.70 ± 4.42^{f}	1.46 ± 0.01^{c}	2.78 ± 0.78^{a}	6.38 ± 0.01^{c}	0.59 ± 0.01^{b}
Sorghum M2	144.26 ± 1.93^{e}	3.62 ± 0.23^{c}	9.96 ± 0.38^{d}	0.52 ± 0.03^{d}	251.99 ± 24.02^{c}	2.58 ± 0.25^{b}	354.55 ± 15.05^{d}	1.36 ± 0.09^{c}	0.66 ± 0.04^{e}	3.18 ± 0.05^{b}	0.60 ± 0.03^{b}
Sorghum M3	143.11 ± 13.63^{e}	6.16 ± 0.01^{b}	9.72 ± 0.04^{d}	1.14 ± 0.05^{a}	474.00 ± 6.27^{a}	3.64 ± 0.04^{a}	306.92 ± 10.51^{d}	2.40 ± 0.04^{d}	1.31 ± 0.08^{f}	3.48 ± 0.01^{b}	2.91 ± 0.01^{a}

Mineral Composition of Final Enteral Feed Compounded from Soya Bean, Finger Millet, and Sorghum

Table 6 presents the mineral composition of the final enteral feed formulations (F1–F6) produced from selected blends of processed soybean, finger millet, and sorghum. F1–F3 recorded the lowest Magnesium (Mg) values (63.50 mg/100 g), while F4–F6 recorded significantly higher ($p < 0.05$). values (159.30–164.69 mg/100 g). These higher levels in F4–F6 reflect the incorporation of sprouted or minimally processed cereals, which have been shown to experience increased Mg availability due to cell-wall hydrolysis and phytate reduction during germination (Nkhata *et al.,* 2018; Kumari *et al.,* 2014). The lower Mg in F1–F3 may also indicate the effect of soaking-induced leaching, consistent with earlier findings that Mg is moderately water-soluble and can be lost during soaking (Dey *et al.,* 2025; Rousseau *et al.,* 2020). F1–F3 also recorded the lowest Iron (Fe) levels (1.50 mg/100 g), while F4 had the highest (4.66 mg/100 g), followed closely by F5 and F6. The enhancement in F4–F6 corresponds to the documented increase in Fe bioavailability following germination and the partial breakdown of phytates and tannins (Elliott *et al.,* 2022; Kumari *et al.,* 2014).

The reduced iron in F1–F3 aligns with the inclusion of soaked ingredients, which typically lose Fe due to leaching into processing water (Dey *et al.,* 2025). Calcium (Ca) content increased from 76.72 mg/100 g in F1–F3 to 431.94 mg/100 g in F4. This increase in F4 shows the high Ca contribution from sprouted finger millet, consistent with reports that germination enhances Ca concentration through dry-matter reduction and the release of bound minerals (Nkhata *et al*., 2018; Sheethal *et al.,* 2022; Keyata *et al.,* 2021). F5 and F6 also recorded significantly higher Ca than F1–F3, confirming the strong influence of finger millet inclusion levels on Ca content (Sheethal *et al.,* 2022). Copper (Cu) levels were significantly different among the formulations ($p < 0.05$). F1–F3 recorded the lowest Cu (0.33 mg/100 g), whereas F4 recorded the highest levels (1.02 mg/100 g). This increase in F4 is likely due to the incorporation of debranned or minimally processed soybean fractions, which have been shown to concentrate Cu and other trace minerals after hull removal (Iyabo *et al.,* 2020; Ha *et al.,* 2022).

Phosphorus (P) in F1–F3 recorded the lowest levels (147.60 mg/100 g), while F4 had the highest P concentration (351.98 mg/100 g). The elevated phosphorus in F4–F6 reflects the enrichment effect of sprouting, as germination activates endogenous phytases that hydrolyze phytate, releasing bound phosphorus (Nkhata *et al.,* 2018; Kumari *et al.,* 2014). Lower values in F1–F3 also reflect the earlier effects of soaking, which reduces P through leaching (Dey *et al.,* 2025). Zinc (Zn) levels ranged from 0.998 mg/100 g in F1–F3 to 2.67 mg/100 g in F4, with all differences statistically significant ($p < 0.05$). As with Cu, the higher Zn in F4 likely results from the inclusion of debranned soybean, where Zn tends to be concentrated in cotyledon tissues (Ha *et al.,* 2022). Formulations F5 and F6 showed moderately high Zn content, consistent with contributions from both sorghum and soybean fractions (Keyata *et al.,* 2021). Potassium (K) values differed significantly ($p < 0.05$), with the lowest levels in F1–F3 (452.02 mg/100 g) and the highest in F4 (759.16 mg/100 g). The increased K in F4, F5, and F6 is attributable to the use of sprouted millet and sorghum, as K is a highly mobile mineral that becomes more concentrated during germination due to enhanced translocation and dry-matter loss (Nkhata *et al.,* 2018). The reduced K in F1–F3 is a common effect of soaking, where K is easily leached due to its high solubility (Dey *et al.,* 2025). Sodium (Na) in F1–F3 had slightly lower Na values (7.25 mg/100 g), while F4–F6 ranged from 9.11–9.65 mg/100 g. The modest increase in Na in F4–

F6 may reflect concentration effects following incorporation of sprouted materials, although Na is not typically influenced strongly by germination (Keyata *et al.,* 2021). Aluminum (Al) values ranged from 0.498 mg/100 g (F1–F3) to 4.29 mg/100 g (F4), with differences significant at $p < 0.05$. Higher Al levels in F4–F6 may be due to the use of cereals, which naturally contain more Al than legumes (Iyabo *et al.,* 2020). Formulations F1–F3 consistently contained the lowest mineral content across nearly all parameters. These formulations were largely composed of soaked materials, which showed reduced mineral levels due to leaching, a widely acknowledged effect in cereal and legume processing (Dey *et al.,* 2025; Rousseau *et al.,* 2020). However, formulations F4–F6 recorded significantly higher ($p < 0.05$) concentrations of major (Ca, P, K, Mg) and trace (Fe, Mn, Zn, Cu) minerals. The increases align strongly with the inclusion of sprouted ingredients, which have enhanced nutrient profiles due to enzymatic activation, phytate reduction, and structural modification of the grain matrix (Elliott *et al.,* 2022; Nkhata *et al.,* 2018).

The results emphasize the critical role of processing techniques in modulating mineral availability. Sprouting appears to be the most effective strategy for enhancing total mineral density in composite formulations, whereas soaking leads to nutrient losses (Elliott et al., 2022; Nkhata et al., 2018; Kumari et al., 2014). Formulations F4–F6, characterized by the inclusion of sprouted cereals and debranned legumes, offer better mineral profiles suitable for specialized enteral feeding applications. Their higher levels of Ca, Fe, P, Mn, and K make them valuable for clinical nutrition, especially for patients requiring nutrient-dense, easily digestible feeds (Sheethal et al., 2022; Keyata et al., 2021). Therefore, the findings of this study contribute to the optimization of cost-effective, nutrient-rich feeding powders and supports the integration of indigenous processing techniques into therapeutic food design.

Table 9: Mineral Composition of Final Enteral Feed (F1 – F6) Compounded from Soya Beans, Finger Millet, and Sorghum (mg/100 g dry weight basis)

Sample	**Mg**	**Fe**	**Ca**	**Cu**	**P**	**Zn**	**K**	**Mn**	**Na**	**Al**	**B**
F 1	63.50 ± 2.26^{a}	1.50 ± 0.04^{a}	76.72 ± 1.80^{a}	0.33 ± 0.00^{a}	147.60 ± 2.12^{a}	0.998 ± 0.02^{a}	452.02 ± 1.93^{a}	0.708 ± 0.01^{a}	7.25 ± 3.91^{a}	0.498 ± 0.01^{a}	0.759 ± 0.03^{a}
F2	63.50 ± 2.26^{a}	1.50 ± 0.04^{a}	76.72 ± 1.80^{a}	0.33 ± 0.00^{a}	147.60 ± 2.12^{a}	0.998 ± 0.02^{a}	452.02 ± 1.93^{a}	0.708 ± 0.01^{a}	7.25 ± 3.91^{a}	0.498 ± 0.01^{a}	0.759 ± 0.03^{a}
F3	63.50 ± 2.26^{a}	1.50 ± 0.04^{a}	76.72 ± 1.80^{a}	0.33 ± 0.00^{a}	147.60 ± 2.12^{a}	0.998 ± 0.02^{a}	452.02 ± 1.93^{a}	0.708 ± 0.01^{a}	7.25 ± 3.91^{a}	0.498 ± 0.01^{a}	0.759 ± 0.03^{a}
F4	159.46 ± 3.93^{b}	4.66 ± 0.38^{b}	431.94 ± 6.81b	1.02 ± 0.04^{b}	351.98 ± 2.23^{b}	2.67 ± 0.20^{b}	759.16 ± 3.31^{b}	23.46 ± 0.05^{b}	9.11 ± 3.87^{b}	4.29 ± 0.02^{b}	1.57 ± 0.01^{b}
F5	159.30 ± 1.99^{b}	3.87 ± 0.00^{c}	337.68 ± 5.76^{c}	0.76 ± 0.01^{c}	304.49 ± 3.66^{c}	2.36 ± 0.01^{c}	676.98 ± 5.04^{c}	18.36 ± 0.11^{c}	9.65 ± 3.86^{b}	3.25 ± 0.04^{c}	1.05 ± 0.04^{c}
F6	164.69 ± 3.23^{b}	3.36 ± 0.00^{d}	355.09 ± 3.38^{c}	0.84 ± 0.01^{c}	313.48 ± 0.41^{c}	2.53 ± 0.04^{bc}	701.81 ± 7.39^{c}	19.95 ± 0.20^{c}	9.23 ± 4.39^{b}	2.70 ± 0.01^{d}	1.26 ± 0.02^{c}

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Conclusions

This study successfully formulated and evaluated nutrient-dense enteral tube feed powders from locally available crops such as soybean, finger millet, and red sorghum to address the critical gap of affordable and sustainable clinical nutrition feed powders in resource-limited settings like Nigeria. The results showed that blending these ingredients in a 30:70 (legume:cereal) ratio yielded formulations with a balanced and enhanced nutritional profile. Key findings showed that soybean was the primary contributor of high-quality protein, fat, and dietary fibre, while finger millet and red sorghum provided essential carbohydrates and notable mineral content, particularly calcium from finger millet.

The research also revealed the significant influence of processing methods on the final nutrient composition. Sprouting (germination) was the most effective technique for enhancing the concentration and potential bioavailability of key minerals such as iron, zinc, and phosphorus. However, soaking led to the leaching of water-soluble nutrients. Formulations incorporating sprouted cereals and roasted, debranned soybeans (notably F4, F5, and F6) presented increased profiles of protein, fibre, and essential minerals, making them viable, tailored alternatives to costly commercial enteral formulas.

A key limitation of this work is the absence of *in-vivo* bioavailability studies, sensory evaluation, and shelf-life stability assessments, which are crucial for determining real-world nutrient absorption and practical application. Future research should therefore focus on these aspects, alongside clinical trials to evaluate the efficacy, safety, and patient tolerance of these formulations in hospital settings. In summary, this study provides a scientifically validated, cost-effective blueprint for developing locally-sourced enteral feeds, offering a practical solution to improve nutrition support and mitigate hospital malnutrition in Nigeria and similar regions.

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