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Plant-Based Supplementary Foods from Indigenous Crops: Acceptability and Nutritional Potential for Moderate Acute Malnourished Children

Vanya Pareek[1], Komal Chauhan[1]*, Neetu Kumra Taneja[2], H. S. Oberoi[2]

[1]Department of Food Science and Technology, National Institute of Food Technology Entrepreneurship and Management, Kundli, Haryana, 131028, India
[2]Department of Interdisciplinary Sciences, National Institute of Food Technology Entrepreneurship and Management, Kundli, Haryana, 131028, India
*Corresponding Author: Komal Chauhan (drkomal.niftem@gmail.com)

ABSTRACT: This study aimed to evaluate the acceptability of plant-based indigenous energy-dense protein-rich (EDPR) ready-to-eat supplementary foods developed from germinated cereals, millets, legumes, and peanuts for children with moderate acute malnutrition (MAM). Three supplementary foods, namely paste (P0: control; P6: developed), biscuit (B0: control; B4: developed), and nutribar (N0: control; N5: developed), were compared with a commercially available peanut-based Ready-to-Use Supplementary Food (RUSF) paste (C0) among children aged 6–59 months in the urban area of Faridabad, India. The primary outcome, measured as the amount of food consumed, was highest for N5 (60.97±18.90 g), followed by B4 (60.79±21.30 g), C0 (35.46±17.21 g), P6 (36.27±16.12 g), and P0 (23.03±11.40 g). Protein intake was significantly higher for B4 (8.18±2.87 g), N0 (8.89±3.62 g), and N5 (8.38±2.59 g) than for C0 (5.00±2.53 g), P0 (3.47±1.72 g), P6 (4.92±2.19 g), and B0 (4.10±1.53 g). Likewise, energy intake was significantly greater for B0 (304.41±111.50 kcal), B4 (317.10±109.03 kcal), N0 (301.20±122.69 kcal), and N5 (317.63±98.45 kcal) than for C0 (188.29±91.76 kcal), P0 (133.56±66.41 kcal), and P6 (190.27±92.37 kcal). Among the developed formulations, the biscuit (B4) and nutribar (N5), prepared using germinated soybean, germinated pearl millet, germinated wheat, and peanut, demonstrated superior acceptability, nutrient intake, and sensory attributes. These findings highlight the potential of indigenous plant-derived ingredients to develop sustainable, culturally acceptable supplementary foods that can support dietary management of MAM while promoting the utilisation of underexploited cereal, millet, and legume resources.

INTRODUCTION

Malnutrition remains a global concern, especially among children, adversely affecting their cognitive development, growth, and overall well-being. According to the World Health Organisation (1), globally, 148 million children have been reported to be stunted, 45.0 million were wasted, and 37.0 million were reported to be overweight. In India, as per the National Family Health Survey (2), 31.7% of children under the age of 5 years are reported to be stunted, 18.7% are wasted, and 2.8% are overweight. Despite several preventive and curative measures undertaken by various government and non-government organisations, malnutrition continues to be a major public health challenge, necessitating sustainable and locally adaptable nutritional interventions.

The WHO classifies malnutrition based on weight-for-height z (WHZ) scores or mid-upper arm circumference (MUAC) into Moderate Acute Malnutrition [(MAM) WHZ between −3 and −2 or MUAC between 11.5 and 12.5 cm] and Severe Acute Malnutrition [(SAM) WHZ below −3 or MUAC less than 11.5 cm], respectively. Children with MAM are at a greater risk of morbidity, mortality, and progression to SAM if timely nutritional intervention is not provided (3,4). Hence, managing malnutrition at this stage is of paramount importance (5,6). The WHO recommends ready-to-use supplementary food (RUSF) for treating MAM in children aged 6–59 months. RUSF is an energy-dense, protein-rich, lipid-based paste that provides 510–560 kcal of energy, 11–16 g of protein, and 26–36 g of fat per 100 g (7).

Supplementation with RUSF has been shown to improve the nutritional status of children with MAM. However, challenges remain regarding its palatability, monotony, and sensory acceptability among children, which may influence compliance and consumption (8). Furthermore, conventional RUSF formulations rely predominantly on a limited number of ingredients and offer little diversity in product form. The utilisation of indigenous crops, particularly cereals, millets, legumes, and oilseeds, provides an opportunity to develop sustainable plant-based supplementary foods with improved nutritional quality and consumer acceptability. Germination further enhances the nutritional and functional properties of these crops by improving nutrient bioavailability, protein digestibility, and sensory characteristics, thereby increasing their suitability for supplementary food development. Nevertheless, the major limitation in the success of supplementary feeding programmes remains the lack of acceptability and dissatisfaction among children and caregivers with the sensory attributes of these products (9). Therefore, developing diverse, locally produced supplementary foods using indigenous plant resources with enhanced sensory quality and acceptability is the need of the hour.

Thus, the present study was undertaken to evaluate the acceptability of indigenously developed energy-dense, protein-rich (EDPR) ready-to-eat supplementary foods prepared from indigenous crops among children aged 6–59 months with moderate acute malnutrition. The acceptability was assessed through primary outcomes (amount of food consumed, protein intake, energy intake, and discomfort symptoms) and secondary outcomes (sensory evaluation).

MATERIALS AND METHODS

The present study was carried out in the anganwadis surroundings (early childhood care and development centres) of the urban block of Faridabad, Haryana, India. The trial was reviewed and approved by the institutional ethical review board of the National Institute of Food Technology Entrepreneurship and Management, Kundli (NIFTEM-K), with the protocol number vide 5/91/NECHR/22. The trial was registered in the Clinical Trial Registry of India (CTRI) with the trial registration number CTRI/2024/09/073975.

Study design

The study was designed as an acceptability study, with randomized administration/order of products to reduce bias, to assess the acceptability of EDPR supplementary foods [paste (P6), biscuit (B4), and nutribar (N5)] along with their respective control (P0, B0, and N0) and commercial peanut-based RUSF paste (C0) in MAM children of 6-59 months.

Screening and sample size

The screening of the study participants was based on

- **Inclusion criteria**: The children in the age group of 6-59 months were screened for inclusion criteria. The latter included a WHZ score between -2 and -3 for MAM children. The anthropometric measurements, height (cm) and weight (kg), for the WHZ score of each participant were undertaken. The standing height was measured using a stadiometer (Prestige height measuring scale, Model: SM-P-W-210, India), and the length was measured using an infantometer (Otica, Model: Modular Infantometer OHPL, India) to the nearest 0.1 cm. The weight was recorded using a digital weighing machine (GLUN, Model: HOOKTYPE50KGDIGITAL, China) with a precision of 0.01 kg, and the WHZ score was calculated using the WHO Anthro V.3.2.2 software. All the instruments were calibrated for zero error.
- **Exclusion criteria**: The exclusion criteria included children who had a history of chronic illness, any allergy (peanuts, wheat, soybean, and SMP), or suffering from SAM.

The sample size for the acceptability trial was calculated using G* power software (10, 11) with a 5% margin of error. A total population of 500 children were screened, of which 232 were identified as MAM (based on the WHZ score between -2 and -3)

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children; further, 14 were excluded due to various reasons (Figure 1). Therefore, a required sample size of 218 (meeting the inclusion criteria) was selected for the study, which was then randomized (using a random number table) into 7 groups.

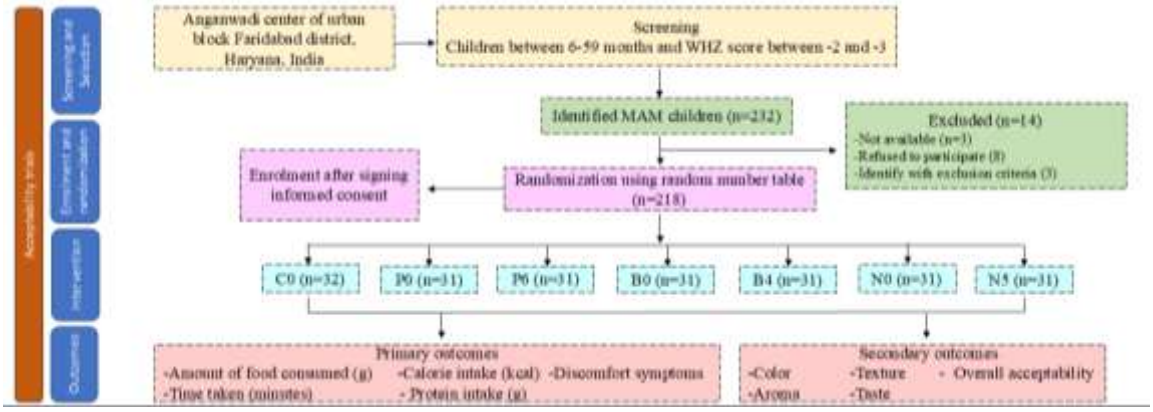


Figure 1. Study flowchart for acceptability study

Informed consent and enrolment

The selected children were randomly divided into 7 groups (n=32 for C0 and n=31 for P0, P6, B0, B4, N0, and N5), two for each product serving as respective control and test groups (Figure 1). One group served as a positive control (C0) and a supplemented commercial sample. The caregivers/ local guardians of the selected children were acquainted with the brief overview of the study, its objectives, protocols involving the acceptability study, and pre-post supplementation nutritional assessment. The acceptability study was explained in detail, and they were asked to submit written informed consent for the voluntary participation of their children in the study. They were also assured that the information gathered would be confidential and only be used for research.

Acceptability study

The EDPR supplementary foods (100 g each) were subjected to an acceptability study for three consecutive days. Compliance was ensured by observing the child for 30 minutes. The "refused intake" was recorded when the child did not consume the product, and an attempt was made the next day. The acceptability study was done in the accustomed surroundings (early childhood care and development centres) of the child (hygienic, ventilated, and not crowded) to negate any kind of uncontrollable pressures that may interfere with the intake. The children in each group were also provided with potable bottled water. The supplements, namely biscuit and nutribar, were coarsely ground and mixed with water for children in the age group of 6-12 months.

The caregivers/ guardians were instructed to immediately report to the early childhood care and development centres (anganwadi centres) for any discomfort symptoms such as rash, vomiting, constipation, and diarrhoea observed in the child after consumption of EDPR supplementary foods. The anganwadi workers and parents were instructed not to feed the child for 2 h before supplementing the products. They were also counselled that these products are supplementary foods and are not a replacement for breastmilk.

The results of the acceptability study were interpreted as primary and secondary outcomes. The former involved the overall amount consumed (g) and the time (minutes) taken by the child to consume the supplementary food. The amount consumed and time taken by each child for each food were calculated by weighing the leftovers using a digital weighing machine (TH-WS05, THERMISTO, New Delhi, India) and a digital stopwatch (XL-5853 Stopwatch, SMIC, New Delhi, India), respectively calibrated to zero error. Further, protein (g) and calorie (kcal) intake were calculated based on the food consumed using the following formula:

Calculations

$$Protein\ (g) = \frac{P \times A}{100}$$

Where,

P = Amount of protein in each supplementary food (100g)

A = Amount of average supplementary food consumed (g)

$$Calorie\ intake\ (kcal) = \frac{A \times E}{100}$$

Where,

A = Amount of average supplementary food consumed (g)

E = Energy content of the supplementary food (100g)

The secondary outcomes involved the degree of liking for the products as perceived by the mother/caretaker on behalf of their child in terms of various attributes, namely color, aroma, texture, taste, and overall acceptability on a nine-point hedonic scale.

Statistical analysis

Results are represented as mean±SD. For the acceptability of foods by children, the Kolmogorov-Smirnov test was used to determine the distribution of the data. Statistical inference was drawn based on a One-Way Analysis of Variance (ANOVA), and the means were separated using Tukey's Honest Significant Difference post hoc test at a significance level of $p \leq 0.05$.

Results and discussions

The developed variants (P6, B4, and N5) conformed to the technical specifications of WHO for supplementary foods, providing 510–560 kcal of energy, 11–16 g of protein, 26–36 g of fat, and the specified micronutrients per 100g. These variants, along with their respective control (P0, B0, and N0) and commercial control (C0), were evaluated for their acceptability.

Acceptability study

An acceptability study was conducted to evaluate the primary and secondary outcomes of plant-based energy-dense protein-rich supplementary foods among children aged 6–59 months with MAM.

Selection of beneficiaries

A total of 500 MAM children in the age group of 6-59 months were screened (WHZ score between -2 and -3) from the anganwadi centres of the urban block of Faridabad, Haryana, India. The selected children (218) were randomly divided into seven groups and were supplemented with commercial RUSF (positive control; C0; n=32), pastes (P6 and P0; n=31 each), biscuits (B4 and B0; n=31 each), and nutribars (N5 and N0; n=31 each). Each group was supplemented with the respective products (100 g) for three consecutive days.

Demographic Profile

The demographic profile of the selected children is depicted in Table 1. At the time of enrolment, no significant difference ($p \geq 0.05$) was observed in the WHZ score and age, with p-values of 0.21 and 0.33, respectively. The results indicate that the intake of each product did not show any marked variation in terms of gender distribution (49.7% females and 50.3% males). Further, the children enrolled in the age groups of 6-12 months, 13-36 months, and 37-59 months were 19%, 44.2%, and 44.7%, respectively.

To assess primary and secondary outcomes, the products (100 g) were given to the respective groups, and compliance was ensured for half an hour.

Table 1. Primary outcomes of the acceptability trial of control and test variants for EDPR supplementary foods

Parameter	C0	P0	P6	B0	B4	N0	N5
Age (months)	31.83±12.18 (27.28, 36.38)	36.80±10.40 (32.95, 40.72)	31.50±13.61 (26.42, 36.58)	34.73±13.31 (29.77, 39.70)	36.90±13.69 (31.79, 42.01)	31.93±10.63 (27.96, 35.90)	32.20±11.78 (27.80, 36.60)
Female, n (%)	16 (50) 16 (50)	14 (45) 17 (55)	16 (51.6) 15 (48.4)	14 (45) 17 (55)	15 (48.4) 16 (51.6)	17 (55) 14 (45)	17 (55) 14 (45)

Male, n (%)							
WHZ score	-2.32±0.27 (-2.42, -2.21)	-2.53±0.72 (-2.80, -2.26)	-2.59±1.03 (-2.98, -2.20)	-2.36±0.46 (-2.54, -2.19)	-2.75±1.07 (-2.99, -2.35)	-2.53±0.66 (-2.76, -2.26)	-2.78±1.03 (-3.00, -2.39)
6-12 months, amount consumed (n)	33.00±32.53 (4)	27.00±24.04 (2)	25.25±18.79 (5)	28.00±21.21 (3)	30.67±31.47 (4)	32.32±8.24 (2)	25.33±15.27 (4)
13-36 months, amount consumed (n)	33.53±20.23 (16)	20.60±11.74 (10)	38.75±15.21 (14)	53.21±19.41 (14)	58.78±16.34 (9)	52.05±22.80 (19)	57.79±10.47 (14)
37-59 months, amount consumed (n)	38.45±10.52 (12)	25.00±11.21 (19)	37.05±16.23 (11)	75.14±9.68 (14)	69.92±11.75 (18)	68.60±20.52 (10)	72.62±15.12 (13)
Amount consumed (g)	35.46±17.21^{b} (20.03, 41.89)	23.03±11.45^{b} (18.76, 27.31)	36.27±16.12^{b} (30.25, 42.29)	60.76±22.58^{a} (52.46, 69.08)	60.79±21.30^{a} (52.83, 68.74)	56.90±23.18^{a} (48.25, 65.55)	60.97±18.90^{a} (53.91, 68.02)
Consumption Time (minutes)	16.57±4.02^{ab} (15.06, 18.07)	14.57±6.57^{b} (12.97, 16.16)	16.43±4.37^{ab} (14.80, 18.06)	16.07±1.91^{ab} (15.35, 16.78)	18.30±4.33^{a} (16.68, 19.92)	18.43±3.78^{a} (17.02, 19.84)	17.13±4.49^{ab} (15.46, 18.81)
Child refused n (%)	0	2 (6.4)	0	0	0	0	0
Protein intake (g)	5.00±2.53^{b} (4.06, 5.95)	3.47±1.72^{b} (2.83, 4.12)	4.92±2.19^{b} (4.10, 5.74)	4.10±1.53^{b} (3.52, 4.67)	8.18±2.87^{a} (7.11, 9.26)	8.89±3.62^{a} (7.54, 10.54)	8.38±2.59^{a} (7.41, 9.35)
Calorie intake (kcal)	188.29±91.76^{b} (154.02, 222.56)	133.56±66.41^{b} (108.77, 158.36)	190.27±92.37^{b} (155.78, 224.76)	304.41±111.50^{a} (262.77, 346.05)	317.10±109.03^{a} (276.39, 357.82)	301.20±122.69^{a} (255.39, 347.01)	317.63±98.45^{a} (280.87, 354.40)
Rash	-	-	-	-	-	-	-
Vomit n (%)	2 (6.2)	1 (3.2)	-	-	-	-	-
Other discomfort symptoms	-	-	-	-	-	-	-

Values: Mean±SD (95% confidence interval), n = 30; Means with different superscripts in a row are considered statistically significant at P ≤0.05; C0: commercially available RUSF; P0: EDPR paste control; P6: EDPR paste test variant; B0: EDPR biscuit control; B4: EDPR biscuit test variant; N0: EDPR nutribar control; N5: EDPR nutribar test variant; WHZ: weight-for-height z score; n: number of participants; other discomfort symptoms: fever, constipation, and diarrhea

Primary outcomes

The primary outcomes of the acceptability study included the amount of product consumed, consumption time, number of children refusing the product, calorie intake, protein intake, and occurrence of discomfort symptoms. The results presented in Table 1 revealed that the maximum amount of product consumed was observed for N5 (60.97±18.90 g), followed by B4 (60.79±21.30 g) and P6 (36.27±16.12 g). Conversely, the lowest consumption was recorded for P0 (23.03±11.45 g), followed by C0 (35.46±17.21 g).

A significant difference ($p \leq 0.05$) was observed in the amount consumed between the developed products and their respective controls for paste [P0 (23.03±11.45 g) and P6 (36.27±16.12 g)] and nutribar [N0 (56.90±23.19 g) and N5 (60.97±18.90 g)], whereas the difference was non-significant for biscuits [B0 (60.76±22.58 g) and B4 (60.79±21.30 g)]. Among different age groups, product consumption among children aged 6–12 months varied non-significantly, ranging from 25.25±18.79 g for P6 to 30.67±31.47 g for B4. The highest intake (72.62±15.12 g) was observed among children aged 37–59 months for N5, whereas the lowest intake was recorded in the 6–12 months age group for P6 (25.25±18.79 g), followed by N5 (25.33±15.27 g).

The findings indicated significantly higher consumption of EDPR ready-to-eat supplementary biscuits and nutribars compared with the EDPR supplementary paste among MAM children. The higher acceptability of these products may be attributed to their familiar formats, improved texture, and ease of consumption compared with paste-based formulations. The consumption levels observed in the present study were higher than those reported by Hossain et al. (12), who documented consumption of 38.8 g and 49.7 g for soy-based and milk-based RUTF, respectively, among 36 children over a period of 30 minutes. The findings were also comparable with an acceptability trial conducted among 42 MAM children, where the mean consumption of Plumpy'Sup and microbiota-directed complementary food was 26% and 32%, respectively (12). Rachmadewi et al. (13) further reported that locally formulated foods prepared from indigenous ingredients resulted in higher consumption (4.5 kg) compared with standard peanut-based RUTF (2.2 kg) during an 8-week intervention in Indonesia.

The time required for consumption of EDPR supplementary foods ranged from 14.57±6.57 minutes for P0 to 18.43±3.78 minutes for N0. The protein intake differed significantly among the products, with lower protein intake observed for C0 (5.00±2.53 g), P0 (3.47±1.72 g), P6 (4.92±2.19 g), and B0 (4.10±1.53 g) compared with B4 (8.18±2.87 g), N0 (8.89±3.62 g), and N5 (8.38±2.59 g). Similarly, calorie intake was significantly lower for C0 (188.29±91.76 kcal), P0 (133.56±66.41 kcal), and P6 (190.27±92.37 kcal) compared with B0 (304.41±111.50 kcal), B4 (317.10±109.03 kcal), N0 (301.20±122.69 kcal), and N5 (317.63±98.45 kcal).

Although consumption of B0 was statistically comparable with B4, N0, and N5, its protein and energy intake were comparatively lower due to differences in nutrient composition. These findings emphasise that acceptability alone may not determine nutritional adequacy; therefore, nutrient density should be considered while developing supplementary foods for children with MAM. The results highlight the potential of EDPR ready-to-eat supplementary foods prepared from locally available plant-based ingredients as acceptable and nutrient-dense alternatives for supporting MAM management.

Two children (6.4%) refused to consume P0 (control paste), whereas no refusal was observed for other products. Since discomfort symptoms following consumption may influence compliance and participation, these parameters were recorded as secondary outcomes. In the present study, vomiting was reported only among children consuming paste formulations, including C0 (6.2%, n=2) and P6 (3.2%, n=1). Caregiver feedback indicated that the thick consistency and texture of the paste formulation were the possible reasons for reduced acceptability.

Overall, the primary outcomes demonstrated that supplementary foods developed using local plant-based ingredients and presented in alternative formats such as biscuits and nutribars exhibited better acceptability among MAM children than paste formulations. These findings are supported by Borg et al. (14), who modified standard RUSF into a locally preferred Cambodian wafer and evaluated its acceptability among 95 malnourished children aged 9–23 months over 12 days. Based on caregiver feedback, the wafer showed higher sensory acceptability than standard RUSF. However, despite higher consumption, actual nutrient intake may vary depending on the nutrient composition of the product. Therefore, supplementary foods should maintain an optimum balance of energy, protein, and other essential nutrients to effectively address the nutritional requirements of children with MAM.

Secondary Outcomes

Sensory evaluation of nutrition supplements among children remains relatively underexplored in the context of public health nutrition. Therefore, the present study documented sensory responses associated with the developed supplementary foods, as taste preferences and sensory experiences are known to vary with cultural and dietary backgrounds (15). The secondary outcomes of the acceptability trial (Table 2) were assessed through caregiver-reported sensory scores for attributes including color, aroma, texture, taste, and overall acceptability.

Among all the developed supplementary foods, N5 received the highest sensory scores for aroma (8.0±0.79), texture (8.2±0.61), and overall acceptability (8.4±0.57). For color and taste attributes, the highest scores were recorded for C0 (8.1±0.71) and N0 (8.0±0.64), respectively. In contrast, P0 exhibited the lowest overall acceptability score (5.6±1.00), followed by P6 (6.4±0.86) and C0 (6.5±1.04). Similarly, the lowest scores for individual attributes, including color (5.9±0.92), aroma (6.6±0.93), texture (5.2±0.91), and taste (5.7±1.21), were observed for P0. The lower sensory scores of paste formulations may be associated with their thick consistency and texture, which may have reduced preference among young children.

The findings of the present study are consistent with those reported by Nga et al. (16), who developed a compressed snack bar using locally available ingredients for malnourished children in Vietnam. The acceptability of the developed energy bar was compared with Plumpy'nut® among children aged 3–5 years (67 children in each group) over a 4-week intervention period. The study demonstrated higher acceptability of the energy bar compared with Plumpy'nut® across all sensory attributes.

In the present study, the sensory outcomes of the acceptability trial were consistent with the findings of the sensory evaluation conducted during Phase 1. The sensory appraisal indicated that indigenous EDPR ready-to-eat supplementary foods, particularly in biscuit and nutribar forms, exhibited higher acceptability compared with the commercial control. Conversely, paste formulations (P0 and P6) received comparatively lower sensory scores and showed acceptability patterns similar to C0. Reggi et al. (17) reported that paste-based RUSF formulations may differ from commonly consumed foods in the general population, potentially increasing the likelihood of rejection due to unfamiliar texture and eating experience.

The findings emphasise the importance of developing energy-dense and protein-rich supplementary foods that not only meet nutritional requirements but also align with children's sensory preferences. Incorporating locally available plant-based ingredients into familiar food formats such as biscuits and nutribars may enhance acceptability, improve dietary compliance, and increase the potential utilisation of supplementary foods in MAM management without compromising nutritional quality.

Table 2. Secondary outcomes for acceptability trial control and Test variants for EDPR supplementary foods

Study food	Color	Aroma	Texture	Taste	Overall Acceptability
C0	8.1±0.71^{a}	7.7±0.58^{a}	6.4±0.68^{c}	6.6±0.88^{b}	6.5±1.04^{b}
P0	5.9±0.92^{b}	6.6±0.93^{b}	5.2±0.91^{d}	5.7±1.21^{c}	5.6±1.00^{c}
P6	7.8±0.59^{a}	7.8±0.55^{a}	6.5±0.57^{c}	6.7±1.12^{b}	6.4±0.86^{b}
B0	7.7±0.75^{a}	7.6±0.92^{a}	7.2±1.14^{b}	7.5±1.22^{a}	8.0±0.61^{a}
B4	7.7±0.78^{a}	7.7±0.91^{a}	7.5±1.11^{b}	7.6±1.03^{a}	7.8±0.68^{a}
N0	7.9±0.72^{a}	7.9±0.71^{a}	7.9±0.61^{ab}	8.0±0.64^{a}	8.3±0.53^{a}
N5	7.8±0.71^{a}	8.0±0.79^{a}	8.2±0.61^{a}	7.9±0.69^{a}	8.4±0.57^{a}

Values:Mean±SD (n = 30); Means with different superscripts in a column are considered statistically significant at P ≤0.05; C0: commercially available RUSF; P0: EDPR paste control; P6: EDPR paste test variant; B0: EDPR biscuit control; B4: EDPR biscuit test variant; N0: EDPR nutribar control; N5: EDPR nutribar test variant

CONCLUSION

The present study demonstrated the acceptability potential of indigenous energy-dense protein-rich (EDPR) ready-to-eat supplementary foods developed from locally available plant-based ingredients for children with MAM. The higher acceptability

of biscuit and nutribar formulations highlights the importance of utilising indigenous crops and developing diversified food formats to enhance sensory preference and dietary compliance. These findings support the role of plant-based food innovations in designing culturally acceptable and nutrient-dense supplementary foods for addressing nutritional challenges. The developed formulations offer scope for integration into community-based nutrition programmes; however, further clinical investigations are required to establish their effectiveness in improving nutritional outcomes. Future research should focus on evaluating these formulations among different age groups, including children with severe and moderate acute malnutrition, and exploring their application in adult malnutrition. Additionally, standardisation of formulations using cost-effective plant protein sources with reduced dependence on milk-based ingredients may enhance affordability, scalability, and sustainable utilisation of indigenous plant resources.

Author contributions

Vanya Pareek: Conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, software, validation, visualization, writing – original draft, writing – review, and editing. **Komal Chauhan:** Conceptualization, supervision, project administration, visualization, writing - review and editing. **Neetu Taneja**: Resources. **Harinder Singh Oberoi**: Resources

Data availability statement

The authors confirm that the data supporting the findings of this study are available within the article.

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Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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