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Development of a Madura local ready-to-use therapeutic food (RUTF) formulation based on peanuts and maize: Sensory and nutritional evaluation

Pengembangan formulasi Ready-to-Use Therapeutic Food (RUTF) lokal Madura berbasis kacang tanah dan jagung melalui evaluasi sensorik dan nilai gizi

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Abstract

Severe acute malnutrition (SAM) among children younger than 5 years remains a critical public health problem that requires effective interventions, including ready-to-use therapeutic food (RUTF). The use of local food ingredients may improve the availability, affordability, and sustainability of RUTF. This study evaluated the acceptability and nutritional characteristics of peanut- and maize-based RUTF developed using local food resources in Madura. A laboratory-based experimental study was conducted using a completely randomized factorial design with two factors: peanut–maize flour ratio and vegetable oil type. Nutritional analysis was performed at the Unit Layanan Pengujian (ULP) Laboratory, Universitas Airlangga, and sensory testing was conducted at Politeknik Negeri Madura. A hedonic test was used to assess the color, aroma, taste, texture, and overall acceptability of the bread by 40 semi-trained panelists. Data were analyzed using two-way ANOVA followed by Tukey's post hoc test, and the selected formulations were subsequently evaluated for nutritional composition. A significant interaction between flour ratio and oil type was observed for aroma, taste, texture, and overall acceptability ($p < 0.05$), but not for color. Formulation X1Y2 had the highest overall acceptability score (4.32 ± 0.52). X1Y2 contained 1.19% moisture, 10.0% protein, 48.4% fat, and 604.2 kcal/100 g; its energy value exceeded the stated WHO and UNICEF ranges, whereas iron and calcium were below the recommended ranges.

Keywords: Local food, maize, nutritional value, peanuts, ready-to-use therapeutic food (RUTF), sensory evaluation

Abstrak

Malnutrisi akut berat pada anak balita masih menjadi masalah kesehatan masyarakat yang memerlukan intervensi efektif, termasuk pemberian pangan terapeutik siap digunakan/Ready-to-Use Therapeutic Food (RUTF). Pemanfaatan bahan pangan lokal dapat meningkatkan ketersediaan, keterjangkauan, dan keberlanjutan RUTF. Penelitian ini bertujuan mengevaluasi daya terima dan karakteristik gizi RUTF berbasis kacang tanah dan jagung yang dikembangkan dari sumber pangan lokal Madura. Penelitian eksperimental laboratorium menggunakan rancangan acak lengkap pola faktorial dengan dua faktor, yaitu rasio tepung kacang tanah–jagung dan jenis minyak nabati. Analisis kandungan gizi dilakukan di Laboratorium ULP (Unit Layanan Pengujian) Universitas Airlangga, sedangkan uji sensorik dilaksanakan di Politeknik Negeri Madura. Penilaian menggunakan uji hedonik terhadap warna, aroma, rasa, tekstur, dan penerimaan keseluruhan oleh 40 panelis semi-terlatih. Data dianalisis menggunakan ANOVA dua arah dan uji lanjut

Tukey. Hasil menunjukkan adanya interaksi signifikan antara rasio tepung dan jenis minyak terhadap aroma, rasa, tekstur, serta penerimaan keseluruhan ($p < 0,05$), tetapi tidak terhadap warna. Formula X1Y2 memiliki tingkat penerimaan keseluruhan tertinggi (4,32 ± 0,52). Analisis gizi X1Y2 menunjukkan kadar air 1,19%, protein 10,0%, lemak 48,4%, dan energi 604,2 kkal/100 g; nilai energi melebihi rentang standar yang dicantumkan, sedangkan zat besi dan kalsium berada di bawah rentang yang direkomendasikan.

Kata Kunci: Jagung, nilai gizi, kacang tanah, pangan lokal, RUTF, uji sensorik

Introduction

Indonesia faces complex public nutrition challenges, commonly described as the triple burden of malnutrition, in which undernutrition, overnutrition, and micronutrient deficiencies coexist within the same population (UNICEF, 2020b). Undernutrition remains a major concern, particularly among children younger than 5 years. Severe acute malnutrition results from inadequate energy and nutrient intake and is identified by a weight-for-height z-score < −3 SD and/or a mid-upper arm circumference (MUAC) < 115 mm among children aged 6–59 months (Dipasquale et al., 2020; WHO, 2023). If not appropriately managed, acute malnutrition substantially increases the risk of mortality, delayed cognitive development, and long-term growth impairment (Kirolos et al., 2022).

Children younger than 5 years with severe acute malnutrition have a markedly increased risk of psychomotor delay, cognitive impairment, and susceptibility to infection (Kirolos et al., 2022). In Indonesia, undernutrition in children remains a substantial public health concern. According to the 2023 Indonesian Health Survey (Survei Kesehatan Indonesia [SKI]), the prevalence of severe underweight was 3.0% nationally and 2.0% in East Java, while the prevalence of underweight was 12.9% nationally and 11.3% in East Java. In addition, the prevalence of severe stunting was 5.7% in Indonesia and 3.8% in East Java, with an overall stunting prevalence of 15.8% nationally and 13.8% in East Java (Badan Kebijakan Pembangunan Kesehatan, 2023). These figures indicate that acute and chronic undernutrition remain important public health concerns. In the Madura region, particularly in Sampang Regency, child malnutrition continues to be reported despite substantial local food production potential that could support nutrition-specific interventions and community-based prevention and management strategies.

The WHO and UNICEF recommend ready-to-use therapeutic food (RUTF) as part of the management of severe acute malnutrition. RUTF is an energy-dense, micronutrient-rich food that can be consumed directly and is specifically formulated for children younger than 5 years of age without medical complications (WHO, 2021). RUTF improves the nutritional status and shortens the recovery time in children with severe acute malnutrition (Abebe et al., 2023). However, most RUTF products used in Indonesia are imported, which may limit their affordability and distribution and may not fully align with local taste preferences.

In this context, a community-based nutrition approach emphasizes the development of solutions that utilize local resources. One strategy is to use local food ingredients, such as peanuts and maize, which are widely available in the Madura region. According to Statistics Indonesia (BPS), Madura Island is a major producer of peanuts and maize in East Java. National maize production reached approximately 15.14 million tons in 2024, with East Java being the leading producing province (BPS, 2025). These data indicate that maize is a widely available raw material for food-based intervention. In addition, peanuts and maize are commonly consumed in traditional foods, which may support their acceptance by local communities (BPS, 2018a, 2018b).

In addition to nutritional value and raw material availability, successful RUTF implementation depends on product acceptability. Previous studies have indicated that sensory acceptability can influence adherence and sustained consumption, particularly among children who may be sensitive to taste, texture, and aroma (Choudhury et al., 2017). Acceptability testing is an important stage

in therapeutic food development because it helps assess whether a formulation is likely to be consumed as intended. Contemporary sensory science frameworks describe food acceptance as multidimensional, shaped not only by intrinsic sensory characteristics such as taste, aroma, color, and texture, but also by extrinsic factors, including familiarity, cultural relevance, caregiver perception, and social context (Sokra et al., 2026). The present study focused on intrinsic sensory attributes under controlled experimental conditions to evaluate and optimize the RUTF formulation based on its sensory and nutritional characteristics. Extrinsic factors were not included in the study design to minimize confounding and attribute the observed acceptability differences to the formulation components.

The food-based approach to local RUTF development emphasizing nutrient-dense, affordable, and culturally acceptable local foods represents a relevant response to Indonesia's nutritional challenges. This approach may address malnutrition while supporting food sustainability and community food self-reliance (UNICEF, 2020a).

Based on this background, this study aimed to evaluate the acceptability of RUTF developed from local peanuts and maize as a candidate product intended for children younger than 5 years with severe acute malnutrition. This study also aimed to identify the preferred formulation based on overall acceptability as a foundation for developing a sustainable and locally appropriate RUTF product.

Methods

Study Design

This laboratory-based experimental study used a controlled formulation approach and a completely randomized factorial design with two treatment factors and two replications in each group. The study was conducted between September and November 2025. Nutritional composition analysis was performed at the Unit Layanan Pengujian (ULP) Laboratory of Universitas Airlangga, while sensory testing was conducted at Politeknik Negeri Madura.

The treatment factors were factor X, the peanut-to-maize flour ratio, and factor Y, which was the type of vegetable oil (palm oil or coconut oil). Factor X was selected based on protein quality and amino acid complementarity, particularly the balance of limiting amino acids in plant-based formulations. Peanuts are rich in lysine but relatively low in sulfur-containing amino acids, whereas maize has a complementary amino acid profile but is limited in lysine content. Accordingly, the selected ratios (25:13 and 25:15) were adapted from previous RUTF and complementary food formulation studies, emphasizing nutrient density, protein adequacy, and alignment with general RUTF nutritional recommendations. The formulation was determined by considering the limiting amino acid adequacy and total protein content. The 30-g quantity of vegetable oil was based on estimated energy requirements and RUTF paste specifications and was intended to produce a smooth, homogeneous, and viscous paste (UNICEF, 2022).

Table 1. RUTF paste formulation

Ingredient	X1Y1	X2Y1	X1Y2	X2Y2
Peanut flour (g)	25	25	25	25
Maize flour (g)	13	15	13	15
Palm oil (g)	30	30	0	0
Coconut oil (g)	0	0	30	30
Full-cream milk powder (g)	30	30	30	30
Powdered sugar (g)	1	1	1	1
Vitamin–mineral mix (g)	0.75	0.75	0.75	0.75

Note: The formulation codes represent combinations of the two experimental factors. Factor X refers to the peanut-to-maize flour ratio, where X1 = 25 g peanut flour:13 g maize flour and X2 = 25 g peanut flour:15 g maize flour ratio. Factor Y refers to the type of vegetable oil, where Y1 = palm oil (30 g) and Y2 = coconut oil (30 g) in this study. Thus, each formulation represents a specific combination of these two factors.
X1Y1: 25 g peanut flour + 13 g maize flour + palm oil
X2Y1: 25 g peanut flour + 15 g maize flour + palm oil
X1Y2: 25 g peanut flour + 13 g maize flour + coconut oil
X2Y2: 25 g peanut flour + 15 g maize flour + coconut oil
All formulations contained equal amounts of full-cream milk powder (30 g), powdered sugar (1 g), and vitamin–mineral mix (0.75 g).

RUTF Preparation Procedure

The RUTF preparation procedure began by roasting peanut flour for approximately 15 min at 130 °C and maize flour for approximately 15 min at 115 °C, followed by sieving to obtain fine flours. All the dry ingredients (peanut flour, maize flour, milk powder, sugar, and vitamin–mineral mix) were thoroughly mixed, after which the vegetable oil was added. The mixture was stirred until a homogeneous paste was formed, weighed according to the serving size, and packaged in clean, tightly sealed containers (Schoonees et al., 2019).

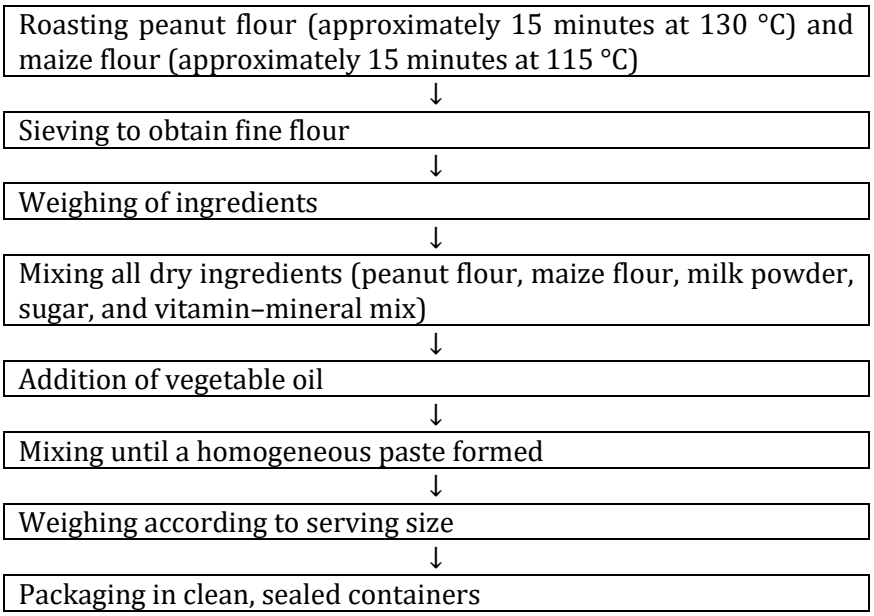

Figure 1. Flowchart of the RUTF paste preparation procedure

Sensory Evaluation Procedure

Sensory acceptability was evaluated using a hedonic test for color, aroma, taste, texture, and overall acceptability scores. A five-point hedonic scale was used: like very much (5), like (4), moderately like (3), dislike (2), and dislike very much (1). The selected formulation was defined as the one with the highest overall acceptability score (Yakubu et al., 2025). The selected formulations were subjected to nutritional analysis.

The sensory evaluation included 40 semi-trained panelists. The panelists were university students selected based on good sensory acuity, good health, and no history of food allergy to any ingredient used in the study.

Nutritional Composition Analysis

The nutritional composition analysis of RUTF included determination of moisture content using the gravimetric method, protein content using an AOAC method, fat content according to SNI 2354-3:2017, and carbohydrate content calculated by difference in accordance with SNI 01-2891-1992.

Dietary fiber was analyzed using an enzymatic–gravimetric method (AOAC Official Method 991.43). The iron and calcium contents were determined using atomic absorption spectrophotometry (AAS). The energy value was calculated using the Atwater factors.

Data Analysis

Data were processed using Microsoft Excel 365 and SPSS version 21.0 for Windows operating system. The nutritional composition of the selected RUTF formulations, including moisture, fat, protein, carbohydrate, energy, dietary fiber, iron, and calcium, is summarized as mean ± SD. Hedonic scores for color, aroma, taste, texture, and overall acceptability were analyzed using two-way analysis of variance (ANOVA), followed by Tukey's post-hoc test when significant differences were observed.

Ethical Considerations

This study was approved by the Research Ethics Committee of the University of Surabaya (approval no. 684/KE/IX/2025; September 9, 2025). All panelists received detailed information about the study objectives, procedures, and potential risks, and provided written informed consent.

The ethical principles applied in this study included the protection of panelist confidentiality, use of safe food materials, and implementation of procedures designed to pose no health risk to participants.

Result and Discussion

Table 2. Nutritional composition of the selected formulation

Nutrient	Selected formulation (X1Y2)	General RUTF standard (WHO, 2021)	RUTF paste standard (UNICEF, 2022)
Moisture (%)	1.19 ± 0.2	2.5 maximum	2.5 maximum
Protein (%)	10.0 ± 0.3	10–12	10–12
Fat (%)	48.4 ± 0.2	45–60	45–60
Carbohydrate (%)	32.0 ± 2.6	-	-
Energy (kcal/100 g)	604.2 ± 10.6	520–550	520–550
Dietary fiber (%)	0.9 ± 1.4	< 5	< 5
Iron (mg/100g)	9.38 ± 0.35	10–14	11–14
Calcium (mg/100g)	151.1 ± 2.42	300–600	300–785

The hedonic test results showed a significant interaction between the peanut and maize flour ratio and vegetable oil type for aroma, taste, texture, and overall acceptability ($p < 0.05$), whereas color did not differ significantly among the treatments. The mean color preference scores ranged from 3.67 to 4.12, indicating that variations in the peanut–maize flour ratio and vegetable oil type did not substantially affect the perceived RUTF paste color.

For aroma and taste, formulations X1Y1, X2Y1, and X1Y2 had higher preference scores and did not differ significantly from one another, whereas X2Y2 had the lowest scores and differed significantly from the other formulations. These results suggest that a higher proportion of maize combined with coconut oil tends to reduce aroma and taste acceptability.

The largest differences were observed in texture and overall acceptability. Formulation X1Y2 had the highest texture (4.15 ± 0.48) and overall acceptability (4.32 ± 0.52) scores and differed significantly from the other formulations, whereas X2Y1 had the lowest scores for both attributes. These findings indicate that coconut oil combined with a lower proportion of maize produced a more preferred paste texture and higher overall acceptability among the panelists. Overall, X1Y2 (25 g peanut flour, 13 g maize flour, and coconut oil) had the highest panelist preference and was selected for subsequent nutritional analyses.

Table 3. Hedonic test results for RUTF paste

Peanut–maize proportion	Vegetable oil	Color	Aroma*	Taste*	Texture*	Overall acceptability*
X1	Y1	4.12 ± 0.33 ^{a}	3.92 ± 0.26 ^{b}	4.05 ± 0.22 ^{b}	3.77 ± 0.42 ^{b}	3.95 ± 0.31 ^{b}
X2	Y1	4.00 ± 0.22 ^{a}	3.97 ± 0.27 ^{b}	3.90 ± 0.30 ^{b}	3.30 ± 0.46 ^{a}	3.27 ± 0.45 ^{a}
X1	Y2	4.00 ± 0.22 ^{a}	3.90 ± 0.30 ^{b}	4.10 ± 0.30 ^{b}	4.15 ± 0.48 ^{c}	4.32 ± 0.52 ^{c}
X2	Y2	3.67 ± 0.47 ^{a}	3.55 ± 0.50 ^{a}	3.45 ± 0.55 ^{a}	3.87 ± 0.40 ^{b}	3.75 ± 0.43 ^{b}

Notes: Different superscript letters within the same column indicate significant differences based on Tukey's test ($p < 0.05$). * Significant interaction between treatments was observed for the marked hedonic attributes. X1 = 25 g peanut flour + 13 g maize flour; X2 = 25 g peanut flour + 15 g maize flour; Y1 = palm oil; and Y2 = coconut oil.

Nutritional analysis of the selected formulation X1Y2 showed that the moisture, protein, fat, and dietary fiber contents met the WHO and UNICEF criteria. The moisture content was low (1.19 ± 0.2%), below the stated maximum, which may support product stability and shelf life. The protein (10.0 ± 0.3%) and fat (48.4 ± 0.2%) contents were within the stated ranges, indicating that the formulation met the primary macronutrient criteria.

Color

The color did not differ significantly among the RUTF paste formulations ($p > 0.05$), with mean

preference scores ranging from 3.67 to 4.12. Thus, variations in the peanut–maize flour ratio and the type of vegetable oil did not significantly affect the perceived product color. All formulations received mean color scores within the generally liked range, indicating favorable visual acceptability among the panelists.

The color of the RUTF paste is primarily influenced by the natural color of the main raw materials and by heat treatment during roasting. Roasted peanuts and maize develop a yellowish-brown color through Maillard and caramelization reactions, which contribute to the characteristic color of legume- and cereal-based products (Starowicz & Zieliński, 2019). In this study, the relatively uniform roasting conditions across formulations likely produced similar color intensities; therefore, differences in maize proportion or oil type did not result in significant sensory differences in color.

The type of vegetable oil also appeared to have a limited influence on the final product color. Palm oil has a naturally yellow hue because of its carotenoid content, whereas coconut oil is generally colorless or slightly transparent. However, in paste products dominated by solid ingredients such as peanuts and maize, the contribution of oil to color may be minor and may be masked by the roasted color of the main ingredients (Amanda et al., 2024). This may explain why the panelists did not perceive significant color differences among the formulations, despite the use of different vegetable oils.

Aroma

Aroma was significantly influenced by the interaction between the peanut–maize flour ratio and vegetable oil type ($p < 0.05$). Formulations X1Y1, X2Y1, and X1Y2 received relatively higher aroma preference scores and did not differ significantly from one another, whereas X2Y2 had the lowest score and differed significantly from the other formulations. These findings suggest that coconut oil combined with a higher proportion of maize tends to reduce aroma acceptability.

The aroma of fat-based food products is influenced by the fatty acid composition and oxidative stability of the oil used in their preparation. Coconut oil is rich in medium-chain fatty acids, particularly lauric acid, and contributes a characteristic aroma when heated or incorporated into semisolid food matrices (Suzuki et al., 2020). In formulations with a higher maize proportion (X2), the characteristic aroma of coconut oil may have become more dominant and interacted with volatile compounds from maize, thereby reducing the panelist preference.

In contrast, palm oil has relatively high oxidative stability because of its natural tocopherol and tocotrienol content, which may contribute to a more neutral aroma in paste-based food products (Fortuna Ayu et al., 2016). This interpretation is consistent with the present findings, in which formulations containing palm oil (Y1) had relatively high aroma acceptability regardless of the maize proportion. In addition, roasting peanuts produces volatile compounds, such as pyrazines, that contribute to a characteristic nutty aroma, which may be less perceptible when stronger volatile compounds from oil or other ingredients are present (Dean et al., 2023).

Taste

Taste was significantly affected by the interaction between the peanut and maize flour ratio and vegetable oil type ($p < 0.05$). Formulations X1Y1, X2Y1, and X1Y2 had relatively high taste preference scores, ranging from 3.90 to 4.10, and did not differ significantly from one another, whereas X2Y2 had the lowest score (3.45 ± 0.55) and differed significantly from the other formulations. These findings suggest that a higher proportion of maize combined with coconut oil tends to reduce taste acceptability.

The taste of paste-based food products is influenced by the raw material composition, fat type, and interactions between volatile and nonvolatile compounds formed during processing. Roasted peanuts produce characteristic flavor compounds, including pyrazines and aldehydes, which contribute to the savory flavor preferred by consumers (Dean et al., 2023). Increasing the proportion of maize in X2 may have diluted the intensity of the peanut flavor and reduced the expected savory character.

The type of vegetable oil also influences flavor development and perception. Palm oil has a relatively neutral taste and is oxidatively stable, which may help preserve the intrinsic flavor of the main ingredients without introducing off-flavors (Amanda et al., 2024; Fortuna et al., 2016). In contrast, coconut oil

contains medium-chain fatty acids that impart a more distinctive flavor. In X2Y2, the coconut oil flavor may have become more prominent in combination with the higher maize proportion, resulting in lower panelist preference (Xing et al., 2025).

Texture

Texture was significantly influenced by the interaction between the peanut and maize flour ratio and vegetable oil type ($p < 0.05$). Formulation X1Y2 had the highest texture preference score (4.15 ± 0.48) and differed significantly from all other formulations, whereas X2Y1 had the lowest score (3.30 ± 0.46). Thus, the lower maize proportion combined with coconut oil produced the most preferred paste texture among the panelists.

The texture of RUTF paste is largely determined by the balance between the solid phase (peanut and maize flour) and fat phase, as well as the physical characteristics of the oil. Coconut oil contains medium-chain fatty acids and has a relatively higher melting point than palm oil, which may allow the formation of a denser, smooth, and homogeneous paste structure at room temperature (Amanda et al., 2024; Suzuki et al., 2020). In X1Y2, the lower proportion of maize may have allowed for better dispersion of solid particles within the fat matrix, resulting in a smoother texture.

Increasing the maize proportion in X2 may increase the starch content and produce a thicker, coarser, or slightly gritty texture if the starch is not adequately dispersed in the fat phase (Araújo et al., 2020). This pattern is consistent with the lowest texture score for X2Y1, in which a higher maize proportion combined with palm oil produced a less preferred texture. This study partially attributed this effect to palm oil being more liquid at room temperature, which could produce a less cohesive paste matrix and greater perceived roughness or textural heterogeneity. Texture is an important RUTF characteristic because children aged 6–59 months require a smooth and homogeneous paste that does not require chewing (UNICEF, 2022). Although X1Y2 was the most preferred texture among the study panelists, direct acceptability testing in the target pediatric population is still required.

Overall Acceptability

Overall acceptability was significantly influenced by the interaction between the peanut–maize flour ratio and vegetable oil type ($p < 0.05$). X1Y2 had the highest overall acceptability score (4.32 ± 0.52) and differed significantly from all other formulations, whereas X2Y1 had the lowest score (3.27 ± 0.45). These findings indicate that the lower maize proportion combined with coconut oil provided the highest overall acceptability among study panelists.

Overall acceptability integrates multiple sensory attributes, particularly taste, aroma, and texture, which contribute to panelist preference (Katunzi-Kilewela et al., 2022). In this study, the high overall acceptability of X1Y2 was accompanied by high taste and texture scores, suggesting that its smoother and more homogeneous texture and preferred flavor may have contributed to the higher overall acceptability despite the absence of significant color differences among formulations.

The type of vegetable oil and the proportion of solid ingredients may also contribute to overall acceptability. Coconut oil, owing to its physical and sensory properties, may form a more cohesive paste matrix when combined with a lower proportion of maize, potentially improving mouthfeel and panelist preference (Zhang et al., 2024). In contrast, X2Y1, which combined a higher maize proportion with palm oil, had the least preferred texture and the lowest overall acceptability. Beyond sensory performance, acceptability is important for RUTF development because greater preference may support adherence to consumption among children with severe acute malnutrition (Rachmadewi et al., 2023; Yakubu et al., 2025).

Nutritional Composition of the Selected Formula

Nutritional analysis indicated that the selected formulation, X1Y2, met several of the stated macronutrient and physical criteria for RUTF. Its moisture content was low (1.19 ± 0.2%) and below the maximum stated by the WHO and UNICEF, which may support microbiological stability and shelf life without refrigeration (UNICEF, 2022; WHO, 2021). Low moisture content may also contribute to a stable paste consistency during storage.

The protein (10.0 ± 0.3%) and fat (48.4 ± 0.2%) contents of X1Y2 were within the stated RUTF range. Protein supports tissue recovery and growth in children with severe acute malnutrition, whereas fat is a major energy source that facilitates the absorption of fat-

soluble vitamins A, D, E, and K (Dipasquale et al., 2020; Schoonees et al., 2019). The high fat content of RUTF also contributes to energy density and palatability, which are important for increasing energy intake in children with a limited appetite.

The energy value of X1Y2 was 604.2 ± 10.6 kcal/100 g, which exceeded the WHO and UNICEF ranges. Although a high energy density may allow energy requirements to be met with a smaller volume of food (Abebe et al., 2023), the observed value exceeded the specified range and therefore warrants a formulation review. The carbohydrate content was 32.0 ± 2.6%; no specific carbohydrate limit was reported in the RUTF standards presented in this manuscript.

The dietary fiber content in X1Y2 was low (0.9 ± 1.4%) and remained below the stated maximum (< 5%). Low fiber content is important in RUTF to reduce the risk of digestive intolerance and maintain high energy availability in young children with vulnerable gastrointestinal function (UNICEF, 2022; WHO, 2021). Thus, the fiber content was consistent with the RUTF criteria presented in this study.

Iron (9.38 ± 0.35 mg/100 g) and calcium (151.1 ± 2.42 mg/100 g) contents were below the stated WHO and UNICEF ranges. These micronutrients are important for hemoglobin formation, immune function, bone growth, and mineralization (Abebe et al., 2023; Dipasquale et al., 2020). Therefore, further formulation adjustments or mineral fortification are needed for X1Y2 to meet the stated micronutrient criteria.

Overall, X1Y2 met the criteria for moisture, protein, fat, and dietary fiber. However, its energy value exceeded the stated range, and its iron and calcium content were below the recommended ranges. Therefore, further formulation optimization is required before the product can be considered fully compliant with the WHO and UNICEF criteria presented in this manuscript.

Conclusion

This study showed that the sensory attributes of the locally developed RUTF were influenced by the interaction between the peanut and maize flour ratio and the type of vegetable oil. X1Y2 had the highest overall acceptability and favorable texture, aroma, and taste scores, while color was acceptable across formulations. Under the sensory evaluation conditions of this study, the lower maize proportion combined with coconut oil produced the most preferred texture and overall acceptability among the semi-trained panelists.

Nutritionally, X1Y2 met the stated moisture, protein, fat, and dietary fiber criteria; however, its energy value exceeded the stated range, and the iron and calcium content remained below the recommended ranges. These findings indicate that local peanuts and maize have potential as ingredients for RUTF development; however, further formulation optimization is needed. Future studies should optimize the energy and micronutrient composition and assess the acceptability of the product directly in the target population under real-life conditions.

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