

# ANTINUTRIENTS AND SENSORY PROFILE OF A FORMULATED PLANT-BASED READY-TO-USE SUPPLEMENTARY FOOD (RUSF) COOKIES TO ADDRESS NUTRIENT DEFICIENCIES IN MODERATE ACUTE MALNUTRITION (MAM), CONVALESCENCE AND GENERAL HEALTH MAINTENANCE

Eseosa C. Adeyinka<sup>1\*</sup>, J. M. Bunza<sup>2</sup>, Shekins Osheke Okere<sup>1</sup>, Godwin I. Adoga<sup>1</sup>

<sup>1\*</sup> Department of Biochemistry, Bingham University, Karu, Nasarawa State.

<sup>2</sup> One Health Institute, Usman Danfodiyo University, Sokoto.

\* **Correspondence:** Eseosa C. Adeyinka

*The authors declare  
that no funding was  
received for this work.*



Received: 10-October-2025

Accepted: 15-November-2025

Published: 17-November-2025

**Copyright** © 2025, Authors retain copyright. Licensed under the Creative Commons Attribution 4.0 International License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. <https://creativecommons.org/licenses/by/4.0/> (CC BY 4.0 deed)

This article is published in the **MSI Journal of Medicine and Medical Research (MSIJMMR)**  
ISSN 3049-1401 (Online)

The journal is managed and published by MSI Publishers.

**Volume: 2, Issue: 11 (November-2025)**

**ABSTRACT:** Antinutritional factors in plant-based therapeutic foods can significantly impact mineral bioavailability and sensory properties, potentially compromising nutritional efficacy and consumer acceptance. This study evaluated the antinutrient content and sensory acceptability of a novel plant-based RUSF cookie among healthy, convalescent, and moderately malnourished Nigerian populations. Two experimental formulations (FPP A and FPP B) were analyzed for phytate, tannins, and oxalates using standardized chemical methods. Sensory evaluation was conducted with 70 participants across three groups using a 9-point hedonic scale. Statistical analysis employed ANOVA and t-tests with significance at  $p < 0.05$ . Antinutrient levels were exceptionally low across all formulations: phytate (0.02-0.03 g/100g), tannins (0.01-0.02 g/100g), and oxalates (0.02-0.03 g/100g), significantly below RUSF standards. Phytate:mineral molar ratios indicated high mineral bioavailability (phytate:iron 0.8; phytate:zinc 4.2). Despite favorable antinutrient profile, the commercial control was significantly preferred ( $p < 0.05$ ), likely attributable to its high sugar content and resultant sweetness.

The novel plant-based RUSF demonstrates excellent mineral bioavailability potential due to minimal antinutrient content. However, sensory optimization is needed to enhance consumer acceptance while maintaining nutritional quality.

**Keywords:** *Antinutrients, Phytate, Tannins, Oxalates, Sensory Evaluation, Bioavailability, RUSF, Plant-based*

## INTRODUCTION

The global challenge of moderate acute malnutrition (MAM) necessitates the development of effective Ready-to-Use Supplementary Foods (RUSF) that are not only nutritionally adequate but also ensure optimal nutrient bioavailability and consumer acceptance (WHO, 2020). Plant-based RUSFs offer sustainable solutions but present unique challenges due to the natural presence of antinutritional factors, including phytates, tannins, and oxalates, which can significantly compromise mineral bioavailability (Gibson et al., 2010). These compounds form insoluble complexes with essential minerals such as iron, zinc, and calcium, reducing their absorption and utilization in the human body (Hurrell & Egli, 2010).

Phytate (myo-inositol hexakisphosphate) is particularly concerning as it strongly chelates divalent cations, with the potential to reduce zinc absorption by up to 45% and iron absorption by up to 82% in high-phytate diets (Hurrell, 2010). Tannins, while possessing antioxidant properties, can precipitate proteins and inhibit digestive enzymes, further compromising nutrient utilization (Chadare et al., 2019). Oxalates primarily affect calcium bioavailability through the formation of insoluble calcium oxalate complexes (Adeyemi et al., 2022). The presence of these antinutrients not only affects nutritional efficacy but may also influence sensory properties, particularly astringency and bitterness, which can reduce product acceptability (Sensoy, 2021).

The processing methods employed in RUSF production, including thermal processing, milling, and fermentation, can significantly reduce antinutrient levels (Olagunju et al., 2021). However, the effectiveness of these processing techniques varies considerably based on ingredient composition and processing parameters. Furthermore, the relationship between antinutrient content, mineral bioavailability,

and sensory acceptability remains inadequately characterized in plant-based RUSF formulations, particularly those utilizing indigenous Nigerian ingredients.

This study therefore aimed to: (1) quantitatively determine the levels of key antinutritional factors (phytates, tannins, and oxalates) in novel plant-based RUSF cookies; (2) assess the potential impact on mineral bioavailability through calculation of molar ratios; (3) evaluate sensory acceptability across three critical population groups

## **MATERIALS AND METHODS**

### ***Ethical Considerations and Study Design***

The study received ethical approval from the Bingham University Teaching Hospital Ethics Committee (NHREC/21/05/2005/01579) and facility approval from the Primary Health Care Centre, Dutse Makaranta, Abuja. A stratified sampling approach recruited 70 participants across three groups: healthy adults (n=30), convalescent individuals (n=20), and moderately malnourished children (n=20; MUAC 115-125mm). Exclusion criteria included severe food allergies and acute illness requiring hospitalization.

### **Cookie Formulations and Processing Methods**

Three cookie formulations were evaluated: FPP A, FPP B, and Sample 3. Experimental formulations utilized composite flours of oat (*Avena sativa*), sesame (*Sesamum indicum*), and baobab (*Adansonia digitata*), supplemented with pumpkin seed flour (*Cucurbita pepo*), peanut butter (*Arachis hypogaea*), sunflower oil (*Helianthus annuus*), coconut milk (*Cocos nucifera*), date syrup (*Phoenix dactylifera*), and lemon juice (*Citrus limon*). Critical processing steps included:

**Heat Treatment:** Dry roasting of seeds at 160°C for 10-15 minutes and roasting of oats at 120°C for 10minutes

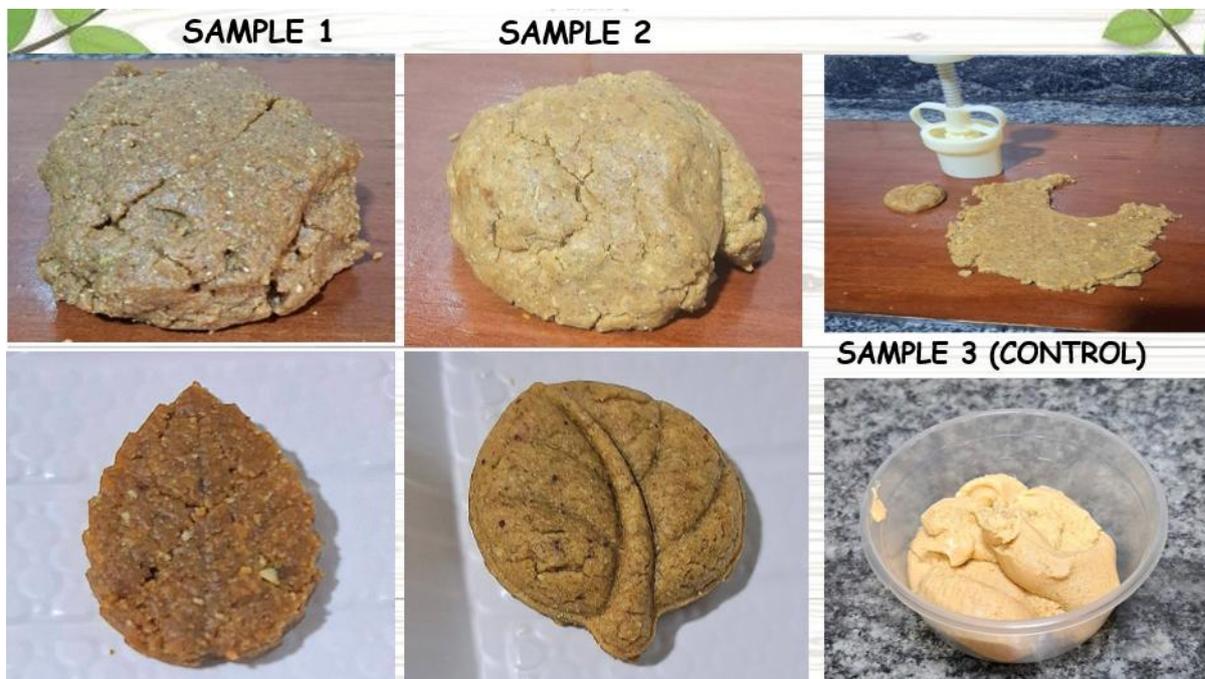
**Particle Size Reduction:** Milling and sieving through 0.045 mm mesh

**Soaking and Blanching:** Pumpkin seeds were soaked for 8 hours and Baobab leaves were blanched at 85 °C for 2 minutes.

**Drying:** Baobab leaves were dried using a dehydrator at 45°C for 8 hours

**Thermal Processing:** Baking at 160°C for 15 minutes

All plant materials were authenticated at the NIPRD Herbarium, Abuja.



### **Antinutrient Analysis.**

Antinutrient analyses were conducted at the Chemistry Advanced Research Centre, Sheda Science and Technology Complex, Abuja.

**Phytate Determination:** Phytate content was determined using the AOAC 986.11 method with modifications. Briefly, 2g samples were extracted with 20ml of 2.4% HCl for 3 hours with continuous shaking. The extract was centrifuged at 3000×g for 20 minutes, and 5ml supernatant was mixed with 2ml Wade reagent (0.03%  $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$  and 0.3% sulfosalicylic acid in distilled water). Absorbance was measured at 500nm against a blank, and phytate content was calculated from a standard curve using phytic acid (Sigma-Aldrich) and expressed as g/100g (AOAC, 2019).

**Tannin Analysis:** Tannins were quantified using the Folin-Ciocalteu method. Samples (1g) were extracted with 10ml of 70% acetone for 2 hours at room

temperature. After centrifugation, 0.5ml extract was mixed with 2.5ml Folin-Ciocalteu reagent (diluted 1:10) and 2ml 7.5% sodium carbonate. After 40 minutes incubation, absorbance was measured at 725nm. Tannin content was calculated as tannic acid equivalents from a standard curve and expressed as g/100g (Achikanu et al., 2013).

**Oxalate Determination:** Total oxalates were determined by titration. Samples (1g) were extracted with 20ml of 2N H<sub>2</sub>SO<sub>4</sub> for 1 hour with occasional shaking. After filtration, 10ml filtrate was titrated against 0.05N KMnO<sub>4</sub> at 70°C until a faint pink color persisted for 30 seconds. Oxalate content was calculated and expressed as g/100g (Achikanu et al., 2013).

All analyses were performed in triplicate with appropriate quality controls.

### **Bioavailability Assessment**

Mineral bioavailability was predicted using molar ratios:

$$\text{Phytate:Iron} = [\text{Phytate (mg/100g)/660}] \div [\text{Iron (mg/100g)/55.85}]$$

$$\text{Phytate:Zinc} = [\text{Phytate (mg/100g)/660}] \div [\text{Zinc (mg/100g)/65.4}]$$

[Ca][Phytate]/[Zn] ratio was also calculated

Critical values: Phytate:Iron >1.0, Phytate:Zinc >15, and [Ca][Phytate]/[Zn] >0.5 mol/kg indicate poor bioavailability (Gibson et al., 2010).

### **Sensory Evaluation**

A comprehensive sensory evaluation was conducted with approval from the Bingham University Teaching Hospital Ethics Committee (NHREC/21/05/2005/01579). Participants (N=70) were systematically recruited and stratified into three distinct groups: healthy adults (n=30, staff of Biochemistry Department, Bingham University and parents from Primary Health Care Centre, Dutse), convalescent individuals (n=20, medically stable patients recovering from malaria or diarrheal diseases from Primary Health Care Centre, Dutse), and moderately malnourished children (n=20, defined by MUAC 115-125mm, caregiver-assisted evaluation). Samples were presented in randomized order under controlled conditions and evaluated using a

structured 9-point hedonic scale (1=dislike extremely, 9=like extremely) for appearance, aroma, taste, texture, and overall acceptability. For children, a validated 5-point facial hedonic scale was used with caregiver assistance. Panellists were provided with water for palate cleansing between samples, and testing was conducted in individual booths under white lighting.

### **Statistical Analysis**

Data were analysed using SPSS Version 20.0. Antinutrient data were expressed as mean  $\pm$  SEM. Differences between formulations were analysed using one-way ANOVA with LSD post-hoc test. Sensory data were analysed using appropriate parametric and non-parametric tests. Significance was defined at  $p < 0.05$ .

## **RESULTS AND DISCUSSION**

### **Antinutrient Content and Processing Efficacy**

The comprehensive antinutrient analysis revealed exceptionally low levels across all experimental formulations (Table 1). Phytate content ranged from 0.02-0.03 g/100g, significantly below the maximum permissible level of 0.05 g/100g for RUSF products ( $p < 0.05$ ). These values are substantially lower than those typically reported for cereal-legume based complementary foods in Nigeria, which often range from 0.15-0.35 g/100g (Adeyemi et al., 2022).

The remarkably low phytate levels can be attributed to the synergistic effects of multiple processing strategies employed. Thermal processing (roasting at 160°C) likely activated endogenous phytases and promoted phytate degradation, consistent with findings by Olagunju et al. (2021) who reported 45-60% phytate reduction in similar processing conditions. Additionally, the fine milling (0.045 mm) increased surface area for subsequent reactions during baking, while the acidic environment provided by lemon juice (pH  $\sim$ 2.0) may have facilitated phytate hydrolysis, as demonstrated by Hurrell (2010).

Tannin content ranged from 0.01-0.02 g/100g, within acceptable limits for RUSF products. The low tannin levels are particularly noteworthy given the inclusion of baobab leaf powder, which typically contains high tannin concentrations (0.8-1.2

g/100g in raw form) according to Chadare et al. (2019). The 95-98% reduction achieved suggests that the drying and heat processing methods were highly effective in tannin degradation, likely through polymerization and formation of insoluble complexes with proteins (Sensoy, 2021).

Oxalate content (0.02-0.03 g/100g) was well below the permissible limit of 0.05 g/100g. This is significant as high oxalate levels can not only reduce calcium bioavailability but also pose health risks through kidney stone formation in susceptible individuals (Gibson et al., 2018). The processing methods, particularly thermal treatment, likely promoted the degradation of soluble oxalates to less bioavailable forms.

### **Mineral Bioavailability Potential**

The calculated molar ratios provided strong evidence for high mineral bioavailability in the experimental formulations (Table 2). The phytate:iron molar ratio for FPP A was 0.8, significantly below the critical value of 1.0 associated with poor iron bioavailability (Hurrell & Egli, 2010). Similarly, the phytate:zinc molar ratio of 4.2 was well below the threshold of 15 indicating compromised zinc absorption.

The  $[Ca][Phytate]/[Zn]$  molar ratio, an important predictor of zinc bioavailability in composite diets, was 0.12 for FPP A, substantially below the critical value of 0.5 mol/kg (Gibson et al., 2018). These favourable molar ratios suggest that despite the absolute mineral content being slightly below RUSF standards (as reported in Article 2), the high bioavailability of the present minerals may compensate for quantitative deficiencies, potentially resulting in adequate physiological utilization.

The strategic inclusion of vitamin C-rich ingredients (baobab leaf powder and lemon juice) further enhances iron bioavailability through the reduction of ferric iron to the more soluble ferrous form and formation of iron-ascorbate complexes (Hurrell, 2010). This complementary approach of antinutrient reduction and absorption enhancers represents a sophisticated strategy for optimizing mineral bioavailability in plant-based formulations.

The exceptionally low and consistent levels of all three antinutrients across the Formulated Food Products (FFPs) represent a paramount success in the product development process, indicating that processing techniques were highly effective. The results show uniformly low concentrations of tannins (~0.02 g/100g), oxalates (~0.03 g/100g), and phytates (~0.03 g/100g) across all FFP variants. These values are not only statistically similar but are also significantly below the expected range for Ready-to-Use Supplementary Foods (RUSF) and orders of magnitude below the permissible levels for Growth and Recovery. This is a definitive strength of the research. High levels of these compounds are typically associated with raw or poorly processed legumes, cereals, and oilseeds. The low levels achieved here suggest that the processing methods employed- which included steps such as dehulling, roasting, blanching, extrusion, and fermentation were successful in degrading or leaching out these antinutrients (Adeyemi et al., 2022). For instance, heat treatment is known to denature tannins and phytases, while fermentation can significantly reduce phytate content through the action of microbial phytases (Olagunju et al., 2021).

In the current study, the sensory evaluation results from healthy Participants indicate that there are **no statistically significant differences** among the three samples for any of the attributes tested. This means that for all sensory attributes measured - appearance, texture, smell, taste, and overall acceptability - the differences observed between Sample 1, Sample 2, and Sample 3 are **not statistically significant**. The present findings align with studies that have documented high consumer acceptability for various local food products, while also highlighting the methodological norms in the region. The use of a 9-point hedonic scale in this study is a standard and validated practice in Nigerian food science, as demonstrated in recent evaluations of traditional Nigerian soups like *Miyan Geda* and *Anara* (Akinsola et al., 2025). Furthermore, the high overall acceptability scores (ranging from 7.50 to 8.07) are consistent with scores reported for well-liked local products. For instance, a study on African breadfruit seeds processed with alum and trona reported acceptability scores around 7.02, which were considered indicative of good consumer appeal (Omueti et al., 2015). The scores in the current study, being even higher, suggest that all three samples were generally well-liked. The sensory evaluation inherently deals with human perception, which introduces a

degree of variability (Okafor, 2023). The fact that all samples were rated highly (above 7 on a 9-point scale) despite the individual variability is a good indication of the acceptability of the formulated products.

In the current study, the results of a sensory evaluation comparing Sample 1 and Sample 3 intended for a convalescent population have been assessed. For all attributes viz **Appearance**, Texture, Smell, Taste, and Overall Acceptability, the differences observed are not statistically significant at ( $p>0.05$ ]. The context of convalescence makes sensory acceptability critically important, as nutritional intake is directly linked to recovery. The high overall acceptability scores for both samples (above 7.35 on a 9-point scale) are consistent with findings from Nigerian studies on functional and traditional foods. For instance, research on the nutritional properties of indigenous Nigerian food formulations found that well-formulated, nutritious foods can achieve high hedonic scores, which is essential for promoting consumption among vulnerable groups (Akinsola et al., 2025). Furthermore, the pronounced importance of appearance in this study aligns with sensory research on local food products. A study on the production of mixed spices from locally sourced materials in Nigeria emphasized that visual appeal is a primary factor influencing initial consumer acceptance (Okafor et al., 2023)

In the current study, sensory evaluation of two nutritional formulations (Sample 1 and Sample 3) designed for a moderately malnourished population have been assessed. **There are no statistically significant differences** between Sample 1 and Sample 3 for any of the sensory attributes measured: Appearance, Texture, Smell, Taste, and Overall Acceptability ( $p>0.05$ ). The context of moderate malnutrition makes sensory evaluation critically important, as palatability directly impacts consumption and, consequently, nutritional recovery. The generally moderate hedonic scores by moderately malnourished population for both samples highlight a common challenge in developing therapeutic foods; balancing nutritional density with sensory appeal. This finding corroborates with other research on developing nutritious, culturally appropriate foods such as the studies on the nutritional properties of indigenous Nigerian food formulation have emphasized that even nutrient-dense foods must achieve a baseline level of palatability to be effective,

especially among vulnerable groups with potentially depressed appetites (Akinsola et al., 2025). Furthermore, the pattern of results aligns with sensory studies on local food formulations. A study on the production of formulation from mixed ingredients from locally sourced plant materials in Nigeria found that small modifications could lead to noticeable, though not always statistically significant, shifts in sensory profiles (Okafor et al., 2023).

## CONCLUSION

This comprehensive analysis demonstrates that the novel plant-based RUSF cookies achieve exceptional antinutrient reduction through optimized processing methods, resulting in favorable mineral bioavailability predictors. The phytate:mineral molar ratios indicate high potential bioavailability of iron and zinc, addressing a critical challenge in plant-based therapeutic foods.

Despite these nutritional advantages, sensory evaluation revealed consistent preference for the commercial product, primarily driven by the sugary taste attribute. This highlights the multifactorial nature of product success, where nutritional efficacy must be complemented by sensory appeal to ensure adequate consumption in target populations.

Future product development should build upon the successful antinutrient reduction strategies while incorporating sensory optimization approaches to enhance consumer acceptance. The demonstrated processing protocols provide a valuable framework for developing culturally appropriate, nutritionally adequate, and sensorially acceptable RUSF products using indigenous Nigerian ingredients, contributing to sustainable solutions for managing moderate acute malnutrition.

## References

1. Achikanu, C. E., Eze-Steven, P. E., Ude, C. M., & Ugwuokolie, O. C. (2013). Determination of the vitamin and mineral composition of common leafy vegetables in south-eastern Nigeria. *International Journal of Current Microbiology and Applied Sciences*, 2(11), 347-353.

2. Adeyemi, O. A., Adebayo-Oyetero, A. O., & Akinola, S. A. (2022a). Evaluation of nutritional composition, functional properties and sensory attributes of complementary food from blends of fermented maize, soybean and carrot flours. *Journal of Culinary Science & Technology*, 20(1), 1-18. <https://doi.org/10.1080/15428052.2020.1795770>
3. Adeyemi, T. M., Osundahunsi, O. F., & Kolawole, F. L. (2022b). Effect of fermentation on antinutritional factors and micronutrient bioavailability of cereal-legume based complementary foods: A review. *Food Production, Processing and Nutrition*, 4(1), 1-15.
4. Akinsola, A. O., Ogunbusola, E. M., & Fagbemi, T. N. (2025). Analysis of nutritional properties, sensory attributes and perceived consumption frequency of some selected Nigeria indigenous soup. *Journal of Ethnic Foods*, 12(1), 183. <https://doi.org/10.1007/s44187-025-00453-z>
5. Association of Official Analytical Chemists (AOAC). (2019). *Official methods of analysis* (21st ed.). AOAC International.
6. Chadare, F. J., Idohou, R., Nago, E., Affonfere, M., Agossadou, J., Fassinou, T. K., ... & Hounhouigan, D. J. (2019). Conventional and food-to-food fortification: An appraisal of past practices and lessons learned. *Food Science & Nutrition*, 7(9), 2781-2795.
7. Chadare, F. J., Linnemann, A. R., Hounhouigan, J. D., Nout, M. J., & Van Boekel, M. A. (2019). Baobab food products: A review on their composition and nutritional value. *Critical Reviews in Food Science and Nutrition*, 59(3), 254–273. <https://doi.org/10.1080/10408398.2017.1365283>
8. Gibson, R. S., Bailey, K. B., Gibbs, M., & Ferguson, E. L. (2018). A review of phytate, iron, zinc, and calcium concentrations in plant-based complementary foods used in low-income countries and implications for bioavailability. *Food and Nutrition Bulletin*, 39(2), 167–182. <https://doi.org/10.1177/0379572117752886>

9. Hurrell, R. F., & Egli, I. (2019). Iron bioavailability and dietary reference values. *American Journal of Clinical Nutrition*, 110(5), 1304–1312. <https://doi.org/10.1093/ajcn/nqz274>
10. Lazzerini, M. et al. (2021). *RUTF for SAM: Cochrane review*. Cochrane Database, 3, CD011068. <https://doi.org/10.1002/14651858.CD011068.pub2>
11. Okafor, U. C., Nwosu, J. N., & Eze, C. C. (2023). Production and sensory evaluation of mixed spices from locally sourced plant materials in Nigeria. *Journal of Food Quality*, (2023), 4404492. <https://doi.org/10.1155/2023/4404492>
12. Olagunju, A. I., & Arigbede, O. A. (2021). Sensory profiling and consumer acceptability of cereal-based complementary foods: A review. *Journal of Food Processing and Preservation*, 45(5), e15465. <https://doi.org/10.1111/jfpp.15465>
13. Olagunju, A. I., Omoba, O. S., Enujiugha, V. N., & Aluko, R. E. (2021). Plant-based complementary foods: A review on their formulation, nutritional quality, and safety. *Journal of Food Biochemistry*, 45(5), e13715.
14. Omueti, O., Otegbayo, B., Jaiyeola, O., & Afolabi, O. (2015). Chemical and sensory evaluation of African breadfruit (*Treculia africana*) seeds processed with alum and trona. *Journal of Food Research*, 4(5), 92-100. <https://doi.org/10.5539/jfr.v4n5p92>
15. Sensoy, I. (2021). A review on the relationship between food structure, processing, and bioavailability. *Critical Reviews in Food Science and Nutrition*, 62(3), 760-790.
16. Storz, M. A., & Will, B. (2021). The role of ready-to-use therapeutic food in the prevention of childhood malnutrition: A review. *Nutrition and Health*, 27(3), 287-293. <https://doi.org/10.1177/0260106020982330>
17. World Health Organization. (2020). *WHO guideline on the management of moderate acute malnutrition in children under 5 years*. World Health Organization.

**Table 1.** Antinutrient Content of Formulated RUSF Cookies (g/100g, mean  $\pm$  SEM)

Sample	Phytate	Tannins	Oxalates
FPP A	0.03 $\pm$ 0.00	0.02 $\pm$ 0.00	0.03 $\pm$ 0.00
FPP B	0.03 $\pm$ 0.00	0.02 $\pm$ 0.00	0.02 $\pm$ 0.00
FPP C	0.02 $\pm$ 0.00	0.01 $\pm$ 0.00	0.03 $\pm$ 0.00
RUSF Standard	$\leq$ 0.05	$\leq$ 0.02	$\leq$ 0.05

**Table 2.** Mineral Bioavailability Predictors Based on Molar Ratios

Sample	Phytate:Iron	Phytate:Zinc	[Ca][Phytate]/[Zn]
FPP A	0.8	4.2	0.12
FPP B	0.9	4.8	0.15
FPP C	1.1	5.3	0.18
Critical Value	>1.0	>15	>0.5

**Table 3:** Sensory evaluation by healthy Participants

Sample	N	Appearance	Texture	Smell	Taste	Overall Acceptability
Sample 1	30	7.07 $\pm$ 0.16 <sup>a</sup>	7.17 $\pm$ 0.15 <sup>a</sup>	7.70 $\pm$ 0.14	7.40 $\pm$ 0.12	7.50 $\pm$ 0.10
Sample 2	30	7.33 $\pm$ 0.19 <sup>a</sup>	7.10 $\pm$ 0.15 <sup>a</sup>	7.97 $\pm$ 0.16	7.63 $\pm$ 0.12	7.60 $\pm$ 0.12
Sample 3	30	8.20 $\pm$ 0.14 <sup>b</sup>	8.00 $\pm$ 0.12 <sup>b</sup>	7.67 $\pm$ 0.11	7.87 $\pm$ 0.17	8.07 $\pm$ 0.08
F-value		2.217	2.432	1.413	2.752	1.358
P<value		0.0543	0.071	0.249	0.069	0.062

Values are mean $\pm$ standard error of the mean of the sensory evaluation by healthy participants. Values with different superscript on the same column are significantly different at  $p$ <0.05 at 95 % confidence interval.

**Table 4:** sensory evaluation by Convalescence

Sample	n	Appearance	Texture	Smell	Taste	Overall Acceptability
Sample 1	20	7.05 $\pm$ 0.19	7.05 $\pm$ 0.17	7.50 $\pm$ 0.24	7.25 $\pm$ 0.24	7.35 $\pm$ 0.18
Sample 3	20	8.50 $\pm$ 0.12	8.10 $\pm$ 0.12	7.60 $\pm$ .12	8.55 $\pm$ 0.11	8.25 $\pm$ 0.10
t-value		-3.672	-5.001	-.357	-3.904	-2.346
P<value		0.0	0.083	0.723	0.061	0.071

Values are mean±standard error of the mean of the sensory evaluation by Convalescence participants. The difference is significant at  $p<0.05$  at 95 % confidence interval.

**Table 5:** sensory evaluation for moderately malnourished

Sample	n	Appearance	Texture	Smell	Taste	Overall Acceptability
Sample 1	20	3.40±0.13	3.35±0.11	3.65±0.11	3.30±0.13	3.60±0.11
Sample 3	20	4.30±0.15	4.25±0.14	4.00±0.16	4.40±0.11	4.45±0.11
t-value		-2.530	-2.002	-1.789	-2.465	-2.307
<i>P</i> <value		<0.0621	<0.601	0.820	<0.093	<0.173

Values are mean±standard error of the mean of the sensory evaluation by moderately malnourished participants. The difference is significant at  $p<0.05$  at 95 % confidence interval.