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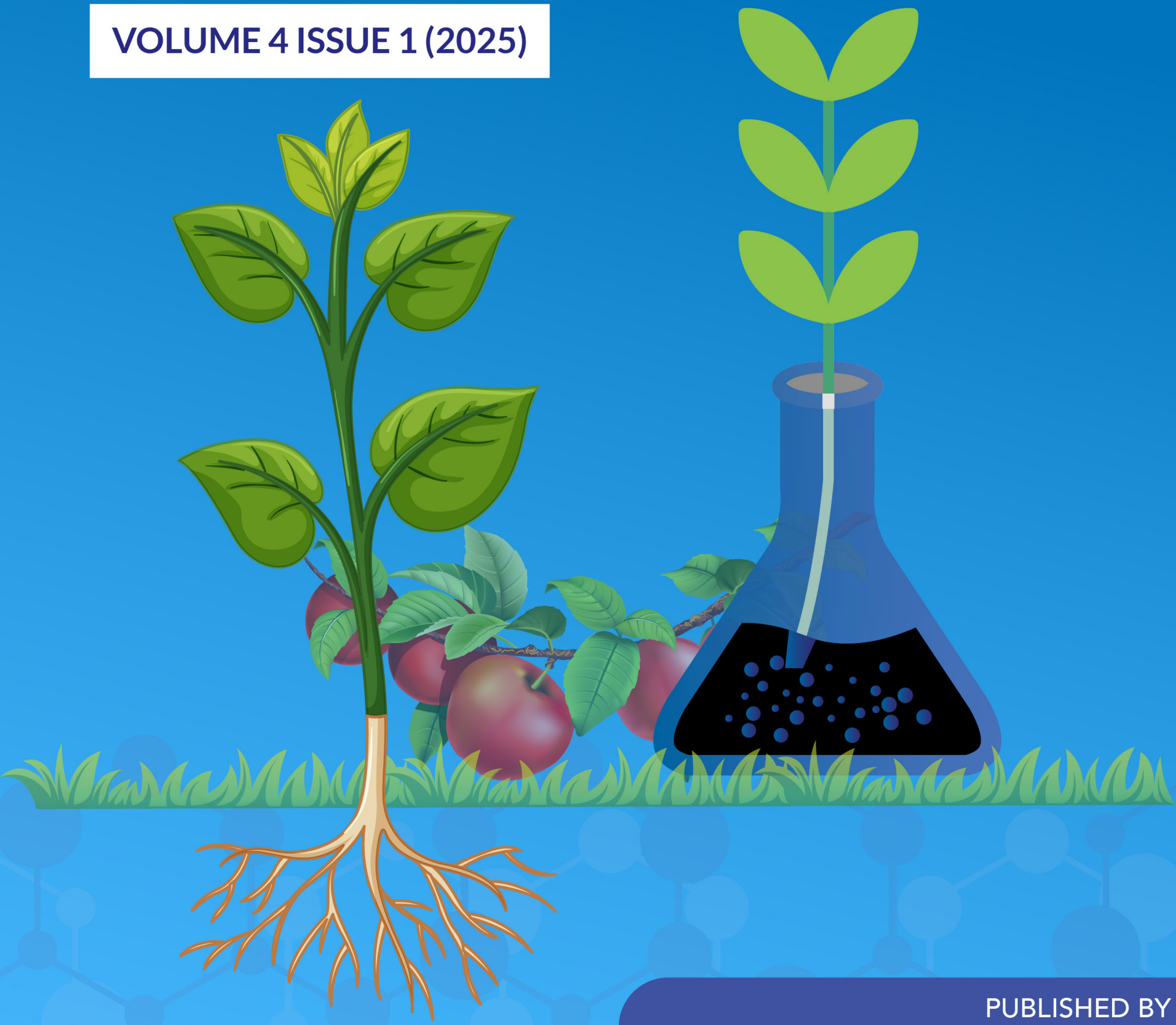

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Optimization the Nutrient Composition and Anti-nutrient of Cereal-Legume Mixtures for Infant Complementary Feeding: A Review

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ABSTRACT

Complementary feeding optimization is the process of improving and adjusting the introduction of solid meals and drinks other than breast milk or formula for infants to infants in addition to nursing. The meal must be nutrient-dense, safe, and suitable for the infant's age and developmental stage as part of this optimization. Recent research on reducing anti-nutritional ingredients and increasing nutrient content in cereal-legume blends for infant feeding. reviewed. Supplemental diets high in nutrients are essential during this time to support the infant's growth, cognitive development, and immune system. Long-term health effects may result from malnutrition, which is especially prevalent in children between the ages of 6 and 24 months as a result of poor feeding practices. Cereal-legume blends are known to have a well-balanced nutritional profile that is appropriate for feeding to infants. Protein quality and nutrient bioavailability can be enhanced by combining legumes like beans, chickpeas, or lentils with cereals like rice, wheat, or maize to form complimentary amino acid profiles. In environments with limited resources, these blends offer a sustainable and affordable way to treat infant malnutrition. Optimizing the nutritional composition and reducing anti-nutrients in cereal-legume blends is a key strategy. While cereals provide carbohydrates but lack vital vitamins and minerals, legumes offer fiber, high-quality protein, and essential nutrients. However, they also contain anti-nutritional substances that can hinder nutrient absorption. To maximize their combined benefits, it's essential to comprehend the nutritional makeup of cereal and legumes separately. Infants can get a lot of energy, protein, and minerals by combining cereals and legumes in complementary foods. In conclusion, optimizing complementary feeding with cereal-legume blends has enormous potential to combat infant malnutrition, especially in environments with limited resources. Researchers want to provide the best possible health and development outcomes for infants during the crucial stage of complementary feeding by improving the nutrient composition, lowering anti-nutrients, and guaranteeing the supply of vital minerals.

INTRODUCTION

Complementary feeding is when solid meals and drinks are introduced to infants in addition to their breast milk or infant food (Gsoellpointner *et al.*, 2024). Complementary foods that are nutritionally adequate have great significance in developing nations (Ikujenlola *et al.*, 2020). Infants no longer receive adequate nutrition from breast milk after six months of age (Tiwari *et al.*, 2021). During the complementary feeding period, infants require a diverse array of nutrients to support their rapid growth, cognitive development, and immune function. Infants, and it is necessary to give nutrient-dense complementary foods, which can affect their nutritional condition both now and in future (Oladiran & Emmambux, 2022). The most common cause of malnutrition in children between the ages of 6 and 24 months is insufficient complementary feeding practices. As a result, they suffer from chronic protein energy malnutrition (PEM), which is often accompanied by micronutrient deficiencies, long-term energy and nutritional deprivation, and failure to reach their full potential for growth and development (Birie *et al.*, 2021).

Cereal-legume mixtures have gained recognition for their ability to offer a well-rounded nutrient profile ideal for infant nutrition (Walle & Moges, 2017). Combining legumes such chickpeas, beans, or lentils with grains like rice, wheat, or maize produces complementary amino acid profiles, higher-quality protein, and better absorption of vital elements (Temba *et al.*, 2016). With their cost-effectiveness and sustainable nature, these mixtures present a promising strategy for combating malnutrition among infants, particularly in areas with limited resources. Optimizing nutritional composition and lowering anti-nutrients in cereal-legume blends is one possible strategy (Walle & Moges, 2017). The most widely consumed staple food worldwide is cereal. They are a good source of carbohydrates, but their nutrient profiles are typically lacking in important vitamins and minerals, even though they do include some micronutrients (Nayik *et al.*, 2023). Conversely, legumes are a great source of fiber, high-quality protein, and several important vitamins and minerals. Though they have many nutritional advantages, legumes also include anti-nutritional substances such tannins, oligosaccharides, and phytates that can reduce the absorption of important nutrients and perhaps cause gastrointestinal distress (Banti & Bajo, 2020).

Cereal and legumes should be combined with complementary foods, especially those made for

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infants, to provide them with high calories, protein, and micronutrients (Walle & Moges, 2017). Combining cereals, such as rice, wheat, or maize, with legumes like lentils, chickpeas, or beans can create complementary amino acid profiles, improve protein quality, and enhance the bioavailability of essential nutrients. Understanding the nutrient composition of cereals and legumes individually is essential to grasp the potential synergies when combined in a mixture (Makori *et al.*, 2017). Although legumes are notable for their high protein content and cereals are high in carbohydrates and energy, they work well together to address the varied nutritional demands of infants (Makori *et al.*, 2017).

This review's goal is to assess the current state of research on maximizing the nutritional composition and anti-nutrient content of cereal-legume blends for newborn feeding. I hope to clarify the potential benefits and challenges of including these blends into infant food by analyzing recent studies and advancements in the field. Additionally, I will discuss how to maximize the nutritional value of cereal-legume blends while minimizing the negative impacts of anti-nutritional components, promoting the best possible development and health for infants.

LITERATURE REVIEW

Nutrient Composition of Cereal-Legume Mixtures

Moisture Content

For this study, which was carried out in Osun State, Nigeria, commercial supplemental food (Control), yellow maize, soybeans, and the yellow species of tiger nut were purchased in a local market in Ile-Ife. The four prepared samples exhibited higher moisture contents (7.2, 7.4, 7.6, and 7.3%) than the control (4.5%) (Ikujenlola *et al.*, 2020). This may be due to the combination of different raw materials and complementary food. This research was done in Benue State, Nigeria and the study was the under-listed grain samples were procured from local markets across. Moisture in the formulated food (10.55%) is higher than the mean moisture in both proprietary formulae (4.35%) but comparable with PAG benchmark for moisture in infant food (10%). This implies that the formulated food will be more susceptible to microbial degradation and will likely have a shorter shelf life than the proprietary food (Oche *et al.*, 2017).

Fiber

A study released on April 19, 2020, from Gonder, Ethiopia, found that the crude fiber content of supplemental foods ranged from 4.69% to 8.36%. These values were higher than those in control diets, with a significant difference ($p<0.05$) among the blended mixtures. The highest crude fiber was found in the diet including soaked, germinated, and roasted chickpeas and sesame, along with spinach (8.36%), while the lowest was in the diet containing soaked, germinated teff and barley, as well as roasted chickpeas and sesame (4.69%) (Geremew Yohannes *et al.*, 2020). The study focused on North Western Nigeria, examining ready-to-eat complementary food samples commonly used in various agro-ecological zones. Researchers collected these samples from mothers or caretakers and stored them in containers at a temperature of 4°C to preserve their quality. The analysis of the samples and the preparation of standard solutions followed the procedures outlined by the AOAC (Association of Official Analytical Chemists) in 1990. The findings revealed that the crude fiber content in these food samples varied, with Guinea corn pap and KBDM having a fiber content of 1.38±0.30%, while the highest recorded fiber content was 2.19±0.60%. This indicates a range of fiber levels in the complementary foods studied (Anigo *et al.*, 2009).

Protein

Inadequate protein intake over an extended period can result in protein deficiency, which can significantly disrupt the growth process (Khan, 2018). Many body processes, including tissue healing, immunological response, and hormone synthesis, depend on protein. The average protein intake among infants was found to be 8.43 ± 0.31 grams per day. This value represents the mean protein consumption, with the standard deviation indicating some variability in intake among different infants (Makori *et al.*, 2017).

The study used yellow sorghum (Sorghum bicolor, cultivar: Safrari) and soybeans (Glycine max, cultivar: M5) from the Institute of Agricultural Research for Development (IRAD) in Garoua, Cameroon. The protein composition of the developed diets ranged from 10.73% (F1) to 20.02% (F8). F1, which was prepared from soaking soybeans and sorghum, had a protein concentration of 10.73%, while F8, which comprised fermented soybeans and germinated sorghum, had a protein content of 20.02% (Tanyitiku & Petcheu, 2022).

The study conducted in Nigeria included buying food goods from Jos local markets, including Nestle Cerelac, a comparative product, from Jos Central Market. The two diets with the highest protein concentrations, ranging from 19.8 to 23.1 grams per 65 grams of food, were those that included acha grain, benniseed, crayfish, and garden egg (ABC) in a 60:25:10:5% ratio and yellow maize, soy beans, and groundnut (MSG) in a 60:30:10% ratio. This quantity exceeded the Recommended Dietary Allowance (RDA) of 13 to 14 grams of protein for infants younger than one year (Mariam, 2005).

This study was conducted in Sinaloa, Mexico, using the Culiaca Experimental Laboratory, QPM (Zea mays L) V-537, and chickpea (C. arietinum L.). The National Research Institute for Forestry, Agriculture, and Livestock (INIFAP) grew 92 types of Blanco Sinaloa on irrigated soil. Superior quality nixtamalized protein maize flour. Mila´n-Carrillo *et al.* (2004) developed NMF, which was released in June 2005. These were the AOAC's official protocols (1995). The optimal mixture used to produce the baby food had 4.41 g of protein (Alarcón-Valdez *et al.*, 2005).

Fat

Dietary fat is essential for several body processes. It offers energy for different activities, helps absorb fat-soluble vitamins (A, D, E, and K), and provides vital fatty acids required for healthy brain development (Aranceta & Pérez-Rodrigo, 2012). In order to conduct the study in Nigeria, food items from local Jos markets were purchased, along with a Nestle Cerelac product for comparison. All three of the local diets had crude fat contents of 65 grams that ranged from 10.1 to 24.8 grams, which is within the 10 to 25 gram Recommended Dietary Allowance (RDA) (Mariam, 2005). The study was done in Alexandria, Egypt. We purchased the seeds of chickpeas, peanuts, soybeans, and Egyptian rice at the neighborhood store. The range of fat levels in blends was between 0.88% and 11.82%, which was adjusted with the infant's weaning needs. All of the blends' fat contents were lower than those of control rice, with the exception of the rice/peanuts mix, which had higher fat than control rice because of the peanuts' high fat content (Tesby Mohamed *et al.*, 2019).

The raw materials for this study were red teff (Eragrostis tef (Zucc.), maize (Zea maize), barley (Hordeum vulgare), wheat (Triticum aestivum), oats (Avena sativa), chickpeas, and Gondar city, Ethiopia. Sufficient amounts of spinach (Spinacia oleracea), sesame (Sesamum indicum), beans (Vicia faba), soy beans (Glycine max), peas (Pisum sativum), and carrots (Cicer arietinum) were collected at the Gondar city local market. We purchased Cerifam, a commercial weaning food, from the Bahir Dar grocery store. Diets 3 and 4 were the only composite diets that met the WHO's minimal requirement of 10–25% fat for newborn meals (Geremew Yohannes *et al.*, 2020).

Ash

This research was carried out in the 2018–19 academic year at the College of Food Technology, VNMKV, Parbhani, India, in the Department of Food Chemistry and Nutrition. The publication date was February 19, 2019. The ash levels in the samples ranged from 1.5 to 1.7, with 30% sorghum, 30% maize, 10% mothbean, and 10% greenpeas having an ash level of 1.65%, 50% sorghum, 10% maize, 5% mothbean, and 15% greenpeas having an ash content of 1.6%, and 30% sorghum, 30% maize, 15% mothbean, and 5% greenpeas having an ash content of 1.65% (Sontakke *et al.*, 2019).

The study was done at the Bahir Dar Institute of Technology's food research laboratory in Ethiopia. It had two replications and was completely randomized. For every mix, the ash concentration was within the acceptable range; nevertheless, it was considerably higher in the cereal:legumes ratio 65:3 (2.27±0.04) than in the ratios 75:25 (2.18±0.02) and 85:15 (2.27±0.04). The reason for this high ash level in B3 could be the incorporation of legumes during manufacture (Walle & Moges, 2017).

Table 1.

Proximate	Amount and references	Amount and references	Amount and references
Moisture	7.2-7.6 (Ikujenlola *et al.*, 2020)	4.35% -10.55%) (Oche *et al.*, 2017)	
Fiber	4.69% to 8.36% (Geremew Yohannes *et al.*, 2020)	1.38±0.30%-2.19±0.60% (Anigo *et al.*, 2009)	
Protein	20.02% (Tanyitiku & Petcheu, 2022)	19.8 to 23.1 (Mariam, 2005)	4.41 g (Alarcón-Valdez *et al.*, 2005)
Fat	10.1 to 24.8 grams (Mariam, 2005)	0.88% to 11.82% (Tesby Mohamed *et al.*, 2019)	10–25% (Geremew Yohannes *et al.*, 2020)
Ash	1.6% -1.65% (Sontakke *et al.*, 2019)	2.27±0.04, 2.18±0.02 and 2.27±0.04 (Walle & Moges, 2017)	
Carbohydrate	56.06 %(Makori *et al.*, 2017)	55.51-64.42%(Oche *et al.*, 2017)	

Carbohydrate

The mixtures' carbohydrate contents ranged from 56.06 % in the 58.6: 11.4: 30.0 (sorghum, pigeonpea, and soybean) flour blend to 57.44 % in the 74.9: 20.1: 5.0 mixture. The minimum and maximum carbohydrate contents were able to provide 2.3 kcal/g and 3.19 kcal/g, respectively, over the WHO norm, suggesting the preliminary optimal energy to meet newborns' energy needs between the ages of 6 and 23 months (Makori *et al.*, 2017). Grain samples purchased from local markets and underlisted were used in this experiment, which was conducted in Benue State, Nigeria. An energy inadequacy is unlikely because the formulated food's caloric value (380 Kcal/100g) is comparable to both proprietary formulae's (410 Kcal/100g), even though the food's total carbohydrate content (55.51%) is only roughly 9% lower than the mean total carbohydrate in both formulae (64.42%) and lower than the PAG benchmark for infant food's carbohydrate content (65%) (Oche *et al.*, 2017).

Mineral

Complementary foods provide between 30 and 97% of the daily sum of micronutrients required. For example, supplemental foods should include 97% iron, 86% zinc, 81% phosphorus, 76% magnesium, 73% salt, and 72% calcium between 9 and 11 months. added to the fact that infants bear only limited gastric capacity to consume adequate quantity of food, the diets need to have very high nutri ent density (Abeshu *et al.*, 2016). Most formulas had a calcium level between 196 and 353 mg per day, and children aged 6 to 23 months were given supplemental foods (Tesha *et al.*, 2022).

Anti-nutrient

Tannins' anti-nutritional effects include slowed growth, lower mineral element bioavailability, and decreased feed efficiency in human diet (Feyera, 2021). Poor bioavailability contributes to the low mineral content of plant-based supplemental diets, particularly when the complementary foods are made from unrefined cereals and legumes that contain high levels of phytate, a strong inhibitor of mineral absorption (Okafor *et al.*, 2018). Because they create insoluble compounds with proteins, antinutrients can reduce their digestibility and palatability. Iron, zinc, calcium, and magnesium are known to form complexes with phytates, which reduces their availability and, consequently, their sufficiency in food samples, particularly for children (Walle & Moges, 2017). Plant polyphenols that occur naturally are called tannins. Their primary function is to bind and precipitate proteins, preventing them from being absorbed and digested.

Phytate content

This study was carried out in Bariga, Lagos State, Nigeria, and the pigeon pea (Cajanus cajan) and dried maize grains (Zea mays) used in the formulation samples were purchased from the Bariga market. The 100:0 maize-pigeon pea ogi had the lowest phytate concentration (90.23 mg/100 g) at the beginning of fermentation (0 hours steeping), whereas the 60:40 ogi had the greatest concentration (446.84 mg/100 g). As the fermentation process came to an end at the 48-hour souring stage, the phytate concentration decreased further, reaching 13.36 mg/100 g in 60:40 maize-pigeon pea ogi and 2.54 mg/100 g in 100:0 maize-pigeon pea ogi (Okafor *et al.*, 2018).

The study was conducted in Ogun State, Nigeria, and the product was made using soybean (Glycine max), pigeonpea (Cajanus cajan), and sorghum (Sorghum bicolor (L) Moench, red variety) seeds that were purchased from Abeokuta local markets. The phytate and oxalate contents ranged from 1.435% in 84.1: 10.9: 5.0 (sorghum: pigeonpea: soybean) flour blend to 1.635% in 49.5: 21.4: 29.1 (sorghum: pigeonpea: soybean) flour blend; 1,155 percent in 58.6: 11.4: 30.0 (sorghum: pigeonpea: soybean) flour blend to 1.330 percent in 62.1: 20.9: 17.1 (sorghum: pigeonpea: soybean) flour blend (Tant *et al.*, 2017).

Table 2.

Anti-Nutrients	Amount and references	Amount and references
phytate content	1.435 %-1.635 % (Tant *et al.*, 2017)	2.54 mg/100 g -13.36 mg/100 (Okafor *et al.*, 2018)
Tannin	18.9-22.9% (Olaniyan SA & Ademola AA, 2015) (Gernar DI, 2014)	23.8-26.7% (Olaniyan SA & Ademola AA, 2015)
trypsin	12.50 (Okafor *et al.*, 2018)	

Tannin

Tannins decrease the effectiveness of mineral absorption and digestibility in cereals and legumes (Samtiya *et al.*, 2020). Tannins are phenolic chemicals that dissolve in water and can precipitate or bind to proteins in aqueous solutions. They decrease the digestibility of grains and legumes by binding to storage proteins. The tannins decreased the availability of minerals, protein, and carbohydrates in the sorghum (Barros *et al.*, 2012). El-Gohery (2021) discovered that biscuits produced with a combination of wheat and lima beans had higher tannin content than biscuits made with sprouted lima beans. According to Olaniyan and Ademola (2015), the malted sorghum-soy composite biscuits had a lower tannin content (18.9-22.9%) than the sorghum cultivars described by Igbua *et al.* (2020), which had a tannin level of 23.8-26.7 %. The malted sorghum-soy composite flour developed in this investigation (Olaniyan & Ademola, 2015) and the sorghum-soy-plantain flour (23.8-27.4%) reported by Gernar (2014) had tannin contents of 18.9-22.9%. According to (Ogbonna *et al.*, 2012), found that the tannin content of malted sorghum flour was higher at 35.8%.

The product from the prepared samples, dried maize grains (Zea mays) and pigeon peas (Cajanus cajan), used in this investigation were bought from the Bariga market in Lagos State, Nigeria. The amount of tannin was discovered to have reduced. The tannin concentration of 60:40 maize-pigeon pea ogi was the greatest at the start of fermentation (0 hours steeping) (18.39 mg/100 g), followed by 70:30 maize-pigeon pea ogi (13.78 mg/100 g) and 100:0 maize-pigeon pea ogi (13.15 mg/100 g). The tannin level continued to drop as fermentation went on, reaching 2.96 mg/100 g in 60:40 maize-pigeon pea ogi, 1.73 mg/100 g in 70:30 maize-pigeon pea ogi, and 0.50 mg/100 g in 100:0 maize-pigeon pea ogi at the 48-hour souring period where the fermentation process came to a conclusion (Okafor *et al.*, 2018).

This study was conducted in Ogun State, Nigeria, and the product was made using soybean (Glycine max), pigeonpea (Cajanus cajan), and sorghum (Sorghum bicolor (L) Moench, red variety) seeds that were purchased from Abeokuta local markets.The tannin concentration ranged from 0.066 percent in the blend of 51.4: 30.0: 18.6 (sorghum, pigeonpea, and soybean flour) to 0.0805 percent in the blend of 74.9: 20.1: 17.1 (sorghum, pigeonpea, and soybean flour) (Tant *et al.*, 2017).

Trypsin

For this research, dried maize grains (Zea mays) and pigeon peas (Cajanus cajan) were purchased from the Bariga market. In Bariga, Lagos State, Nigeria, the study was carried out. The trypsin inhibitor activity (TIA) of different fermenting maize-pigeon pea ogi mixes was analyzed. At the start of fermentation (0 hours steeping), the 60:40 maize-pigeon pea ogi had the highest TIA, followed by the 70:30 (44.30%) and 100:0 (3.19%) types. As fermentation progressed, trypsin inhibitor activity decreased, ending fermentation (48-hour souring) at 12.50% in 60:40 maize-pigeon pea ogi, 10.77% in 70:30 maize-pigeon pea ogi, and 0.10% in 100:0 maize-pigeon pea ogi. (48 hr souring) (Okafor *et al.*, 2018).

This study was conducted in Ogun State, Nigeria, and the product was made using soybean (Glycine max), pigeonpea (Cajanus cajan), and sorghum (Sorghum bicolor (L) Moench, red variety) seeds that were purchased from Abeokuta local markets.In a combination of sorghum, pigeonpea, and soybean flour, the trypsin inhibitor concentration ranged from 31.755 TIU/mg in 65.0: 30.0: 5.0 to 32.140 TIU/mg in 77.3: 5.0: 17.7. pigeonpea, soybean, and sorghum flour combination trypsin inhibitor (Tant *et al.*, 2017).

Optimization Nutritional Requirements for Infants

The experimental results showed a high degree of accuracy as they nearly matched the expected values. In accordance with the anticipated values, proximate compositional analysis showed that the protein, carbohydrate (CHO), and fat contents were 15.12g, 63.67g, and 10.32g, respectively. Calcium (Ca), iron (Fe), zinc (Zn), and magnesium (Mg) all had mineral composition analyses that produced values that were in line with expectations: 169.29 mg, 11.12 mg, 3.84 mg, and 32.48 mg, respectively. These findings indicated that the sample's nutritional quality complied with established standards because they were within the WHO/FAO standard ranges (Aynalem & Duraisamy, 2022).

The moisture content of the formulated flours fell within the range of 6.45 to 11.68 g/100 g dry weight (Muala *et al.*, 2024). With the exception of the sample containing P. biglobosa fermented for 3 days, there were no significant variations in moisture content among the other processing methods. Most formulated samples approached 5 g/100 g DW, aligning with the recommended value for supplementary foods by the World Food Program (Ludi *et al.*, 2017). Through an optimization process focusing on nutritional and sensory qualities, a blend ratio of 55.0 g/100 g oats, 21.0 g/100 g soybean, and 9.0 g/100 g linseed was identified as optimal, yielding compositions of 20.3 g/100 g protein, 9.8 g/100 g fat, 3.2 g/100 g ash, 59.4 g/100 g carbohydrates, 123.2 mg/100 g calcium, and 7.52 mg/100 g iron content (Forsido *et al.*, 2019). All of the infant flour formulations had protein contents higher than the 15 g/100 g DW suggested for infant complementary diets. The lipid content of all the formulas was within the recommended range of 10–25 g/100 g DW Muffins produced from germinated maize (80%) and Bambara nut (20%) flour were compared favorably with a 100% wheat-based muffin in acceptability.

The study revealed the protein, carbohydrate, iron and the energy content of the complementary food blend from 35% cereal and 65 % legume is in the range of FAO/WHO recommended daily intake for 6-23 months. The infant flours formulated in the study exhibited protein contents exceeding the recommended value of 15 g/100 g dry weight for infant complementary foods. The lipid content in all formulas fell within the recommended range of 10-25 g/100 g dry weight as per Stan (Stan, 1991). Muffins made from a blend of germinated maize (80%) and Bambara nut (20%) flour were found to be comparable in acceptability to 100% wheat-based muffins. Additionally, the study highlighted that a complementary food blend comprising 35% cereal and 65% legume met the FAO/WHO recommended daily intake ranges for protein, carbohydrates, iron, and energy for children aged 6-23 months (Walle & Moges, 2017).

The Maize-Bambara nut muffin offers a significant portion of the recommended daily allowances for protein (4.20%) and energy (196.55 kcal), along with zinc (0.72 mg) and iron (50.18 mg). (Tura *et al.*, 2023). Raising the proportion of legumes led to an increase in calcium levels, while the zinc content remained within the recommended range (Walle & Moges, 2017). The concentration of sodium, magnesium, potassium, calcium, iron and phosphorus ranged from 32.02 -52.11; 500.09 – 707.78; 397.01 – 657.80; 250.04 – 506.04, 6.80 – 16.12 and 230.45 – 515.00 respectively (Aderonke Similoluwa Folorunso, 2019).

To validate the optimal condition, the components in the optimized formula were blended, and a laboratory analysis of the micronutrient compositions was carried out. The validation results showed the following values per 100 g of the blend: 31.76 mg of iron, 76.88 mg of calcium, 2.53 mg of zinc, 119.61 mg of magnesium, 440.66 mg of potassium, 291.48 mg of phosphorus, 4.48 mg of sodium, 90.93 mg of phytate, with ratios of 0.236 for Phytate:Iron, 3.52 for Phytate:Zinc, 0.074 for Phytate:Calcium, and 7.22 for Phytate*Calcium:Zinc (Tura *et al.*, 2023).

CONCLUSION

The research on optimizing the nutrient composition of cereal-legume mixtures for infant feeding reveals promising strategies for enhancing the nutritional quality of complementary foods. By blending cereals like rice, wheat, or maize with legumes such as lentils, chickpeas, or beans, complementary amino acid profiles can be improved, enhancing protein quality and nutrient bioavailability. Through investigations into the proximate composition of these blends, including moisture content, fiber, protein, fat, ash, and carbohydrates, researchers have identified the potential to create nutrient-dense complementary foods suitable for infants. While cereals provide carbohydrates and energy, legumes offer fiber, high-quality protein, and essential vitamins and minerals, making them complementary partners in meeting the diverse nutrient needs of infants.

Efforts to optimize the nutritional content of these blends while reducing anti-nutrients such as tannins, oligosaccharides, and phytates have been highlighted. Anti-nutrients can hinder the absorption of vital nutrients and lead to gastrointestinal issues, emphasizing the importance of addressing these factors in formulating complementary foods.

Studies on mineral composition and anti-nutritional effects underscore the need for careful consideration of micronutrient content and potential inhibitors of nutrient absorption in infant foods. By assessing the presence of substances like phytates and tannins, researchers can mitigate adverse effects on nutrient bioavailability and ensure the formulation of nutritionally adequate complementary foods. The validation of optimal nutrient compositions in formulated blends has shown promising results, with significant levels of essential micronutrients like iron, calcium, zinc, magnesium, potassium, and phosphorus. These findings align with established guidelines and recommendations, indicating the potential for these blends to meet the nutritional needs of infants aged 6-23 months.

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