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EVALUATING ACCEPTABILITY OF FORTIFIED JASELOR-BISCUITS AND NUTRITIONAL AND IRON STATUS OF UNDERFIVES IN DRYLAND NUSA TENGGARA TIMUR, INDONESIA

Talahatu AH[1]*, Nur ML[1] and G Oematan[1]



Anna Henny Talahatu

*Corresponding author email: annatalahatu@staf.undana.ac.id
ORCID: https://orcid.org/0000-0002-9545-6005

[1]Department of Public Health, Nusa Cendana University, Kupang, Indonesia

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ABSTRACT

The East Nusa Tenggara region faces a significant public health crisis, characterized by high rates of stunting, wasting, and anemia in children under five years. East Nusa Tenggara experiences low agricultural productivity due to arid conditions, leading to limited availability of diverse, nutrient-rich foods. Sustainable solutions for these problems from the local food scene are required. Jaselor is a biscuit fortified with jagung bose, which is a traditional corn dish, moringa leaves, and fish flour. The aim is to assess sixty children aged 12 to 59 months hemoglobin levels and nutritional status consuming biscuits fortified with Jaselor—a mixture of jagung bose Jaselor (Jagung bose moringa) flour, sorghum flour and fish flour. A quasi-experimental study with a pretest-posttest control group design was undertaken. The acceptability test or level of preference for LTF biscuit products used the Hedonic test and the quality test used an organoleptic test with semi-trained panelists, 30 students from the Faculty of Public Health, University of Nusa Cendana and 30 children underfive years. The concentration of the addition of fish flour, sorghum flour and milk powder in jaselor biscuits gave a significantly different effect on protein levels (14.77%) and carbohydrates (39.25%). The microbial test of normal jaselor flour biscuits did not exceed the provisions of the Indonesian National Standard (SNI) which requires a maximum of 1.8x104 colonies /g bacteria. as well as organoleptic quality both hedonic and scorin. The effect of giving jaselor biscuits showed significant differences in weight gain and Hb levels before (8,997±1,357 kg; 9,677±0,786 gr/dL) and after intervention (10,126±1,676 kg; 10,566±1,8564 gr/dL). Data were examined applying both paired and independent approaches. Supplementation with Jaselor fortified biscuits led to a markedly greater increase in body weight among children, highlighting the effectiveness of the intervention in improving the nutritional status of under-five children. Consumption of the fortified biscuits led to a significant improvement in haemoglobin status and overall nutritional status, as evidenced by anthropometric measurements. The biscuits fortified with iron and the high nutritional value of natural iron from Moringa led to a significant increase in hemoglobin level in study subjects. Jaselor biscuits showed significant success in treating anemia which has grown at alarming levels in the dryland areas and chronic malnutrition status.

Key words: Fortified, Jaselor, Iron Status, Nutritional Status, dry land, east Nusa Tenggara

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INTRODUCTION

Indonesia has the highest prevalence of severe acute malnutrition (SAM). Anemia and poor nutrition are long-term health issues affecting children under five, especially in the dry regions of East Nusa Tenggara (NTT). Anemia and undernutrition are chronic health problems in children under five years old in Indonesia, particularly in the dryland areas of Nusa Tenggara Timur. Malnutrition is still a public health problem in Nusa Province (Southeast NTT) with a prevalence of more than 25% and is one of the highest in Indonesia [1,2]. East Nusa Tenggara had the highest recorded prevalence of stunting at 42.6%, for children under five years of age. Stunting in NTT continues to exceed the national average of 24-30%, which has been relatively stable historically. Part of the national estimates is the 38.5% prevalence of iron deficiency and iron deficiency anemia (IDA) which affects children under five years in rural provinces, including NTT. Indonesia's supplementary food programs include fortified biscuits and health and nutrition education, which have been distributed to children in vulnerable areas, including NTT. These programs were extensive and reached hundreds of thousands of children across provinces. They used locally produced biscuits that were made with government-approved formulations. East of Nusa Tenggara has a dryland environment, food insecurity, and limited dietary diversity place children at a higher risk for iron deficiency and other nutritional deficits. Region-specific therapeutic biscuits made with local ingredients, such as moringa or fish flour, have proven to be effective in improving nutritional intake, and can be tailored to local preferences increasing their acceptability and sustainability. The number of Children Under five years old experiencing nutrition to ascertain whether children under five who reside in dryland areas of Nusa Tenggara Timur, Indonesia, can tolerate biscuits made with fortified sorghum flour and fish flour in jaselor flour, and to ascertain how this relates to their iron and nutritional status.

Nusa Tenggara Timur Province is one of the dry climate areas that is often identified as a poor area that always lacks food (food insecurity) [4]. They are responsible for high rates of iron deficiency, stunting, wasting, and underweight resulting from poor access to food that is both varied and nutrient-dense [5]. The high prevalence of malnutrition Children Under five years old in Kupang Regency is influenced by three main factors, namely poor quality and quantity of food consumption as a result of low family food security, poor parenting patterns and low access to health facilities with details of the characteristics of the influencing factors as follows:(1). food consumption of families and Children Under five years old is low both in terms of quantity and quality does not meet nutritional requirements and is still entirely dependent on subsistence agricultural production). The level of energy, protein, iron, calcium consumption is still far below the Recommended Dietary Allowance (RDA)

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because it is not diverse and unbalanced, only dominated by carbohydrate food sources. Consumption of vitamins and minerals is very low. Children Under five years old generally consume rice porridge or corn porridge without side dishes (empty porridge) [6]. Food sources of vegetable protein are rarely or almost never consumed. Vegetables are given to Children Under five years old but not varied and in small quantities so that children not only have a deficit in macronutrients but also in micronutrients (vitamins and minerals) [2]. Mothers' nutritional knowledge is still low, as is the practice of health care and feeding children including breastfeeding, healthy living behavior of Children Underfives years old mother's parenting patterns, and physical environmental conditions (sanitation and limited clean water), father's and mother's education; physical and economic accessibility is constrained by a lack of sources of income from the agricultural sector and other sectors [7, 8]. Enhancing child nutrition relies either on supplementation or on fortified foods that may not be affordable or culturally acceptable [9]. The more sustainable approach is to develop local food-based solutions that are effective, acceptable, and affordable [10]. The government is taking various measures such as nutrition counseling, food aid, nutritional supplementation, food diversification, and food fortification to overcome the problem of nutritional deficiency [11,12]. Various studies have proven the role of supplementation and fortification of Zn and Fe in linear growth, immunity, infectious diseases and diarrhea in Children Underfives years old [13,14].

Providing additional food aims to improve the nutritional status of children in vulnerable nutritional groups who suffer from malnutrition. According to the Indonesian Ministry of Health [15,16] that the provision of additional food to preschool children should have a nutritional value of around 200-300 calories and 5-8 grams of protein. Local food ingredients have high nutritional value because comes from local seeds that are not transgenic and are developed organically and are free of chemicals, so they are safe for consumption, including Children Under five years old [17]. Corn is a type of cereal that is a staple food for the community, which is usually processed into Corn Bose. Corn Bose is a typical NTT food in the form of porridge made from corn kernels mixed with nuts and cooked using coconut milk [18]. The results of the study showed that providing additional food made from a mixture of corn and soybeans in the form of porridge had an impact on increasing children's nutritional status [19,12]. Moringa oleifera is a very familiar plant for rural communities in NTT with an even distribution pattern. In villages or rural areas, it is widely planted along the edges of fields or rice fields as a living fence. Moringa plants contain high nutrition and are very useful for improving nutrition. Moringa has been proven to be successful in preventing outbreaks of malnutrition in several countries in Africa and saving the lives of several children and pregnant women [20]. Dried Moringa leaves have a nutritional content equivalent to: 10 times the vitamin A contained in carrots, ½ times the vitamin C contained in oranges, 17 times the

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calcium mineral from milk, 15 times the potassium mineral in bananas, 25 times the iron in spinach and 9 times the protein in yogurt. Although many foods contain iron, it is not easily absorbed unless assisted by certain nutrients such as vitamin C [21]. While Moringa leaves contain high levels of vitamin C, they are an excellent source to help absorb iron [11]. Bose corn and moringa leaves are one of the local commodities that can be processed into flour, are continuously available and economically affordable and their nutritional quality is almost perfect, so they are very good to be used as a source of vegetable protein in making Jaselor corn and moringa leaf biscuit formulas specifically for malnourished Children Underfives years old [22].

Jagung Bose is a corn-based dish cooked with various other ingredients such as nuts, vegetables, and spices. Moringa leaves are often added to jagung bose, either cooked together or served as a side dish. Unlike rice, the corn used in Jagung Bose is cooked whole or shelled, then mixed with other ingredients to give it a richer flavor and texture. Jagung Bose is a very important food in the culture of the people of NTT, especially in rural areas. In East Nusa Tenggara, corn is often used as a substitute for rice, as it is easier to obtain and has a longer shelf life. Jagung Bose is also often served at traditional ceremonies or special celebrations as a symbol of unity and togetherness. Jagung Bose is usually served as a staple food in place of rice for breakfast, lunch, and dinner. Moringa is commonly found on the island of Timor and is widely used by the local community as a vegetable. Moringa contains nutrients that are good for the body's health. Moringa Oleifera leaves contain 28.2 mg/100 grams of dried, which is 25 times more than spinach, 3 times more than almonds, and 1.77 times more than what is absorbed into the blood. In addition, the vitamin C content in moringa leaves (Moringa Oleifera) can help the absorption of iron in the intestines. The vitamin C content in moringa leaves (Moringa Oleifera) is 220 mg/100 grams of fresh leaves, which is 7 times more than oranges and 10 times more than grapes. Moringa leaves (Moringa Oleifera) contain 10 times more vitamin A than carrots, which can help maintain bone health. Jaselor is a biscuit fortified with jagung bose, which is a traditional corn dish, moringa leaves, and fish flour. These are all high in iron, protein, and micronutrients [23]. Especially important, both fish flour and moringa have high iron and micronutrient content [24], which can alleviate anemia. Furthermore, using jagung bose supports the local food culture. The purpose of this research was to assess the effect of the consumption of Jaselor-fortified biscuits on hemoglobin levels and nutritional status in children aged 12–59 months in Nusa Tenggara Timur dryland communities.

MATERIALS AND METHODS

This study was an experimental study with a with a Completely Randomized Design (CRD) using the following treatments: namely the addition of Jaselor (Jagung Bose

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Moringa) Flour 60% and Sorghum Flour 30% and Fish Flour 10%. The product combinations are P1: 100 g of Jaselor flour; 30 g of sorghum flour; 30 g of fish flour. P2: 100 g of jaselor flour; 20 g of sorghum flour; 20 g of fish flour, P3: 100 g of jaselor flour; 10 g of sorgum; 10 g of fish flour; P4: 100 g of corn flour; 5 g of sorgum flour; and 5g of fish flour. This study utilized a quasi-experimental design, pretest-posttest (based and end lined). The objective was to estimate the effect of Jaselor enriched biscuits (jagung bose- daun kelor- fish flour; a mix of the three) on children's nutritional status and hemoglobin levels. The study was undertaken in a dryland region of Nusa Tenggara Timur, Indonesia, where childhood anemia and undernutrition are prevalent. The target population consisted of children aged 12–59 months. It recruited participants from community health centers located in rural villages. Data Collection: Purposive sampling was conducted to select a sample of 60 children. The research was conducted in March–November 2024. The acceptability test or level of preference for LTF biscuit products used the Hedonic test and the quality test used an organoleptic test with semi-trained panelists, namely 30 students from the Faculty of Public Health, University of Nusa Cendana and 60 children under 5 years. Analysis of nutrient content was carried out using the Proximate test, including crude fat, crude protein, carbohydrates, energy, water content, and ash content at the Badan POM Balai Besar Pengawasan Obat dan Makanan Kota Kupang. Participants: Under-five children (6-59 months old) identified through community health centers. Inclusion criteria: Children with mild-to-moderate malnutrition or anemia. Exclusion criteria: children with severe malnutrition or underlying medical conditions requiring specific treatment Intervention; In the intervention group, children received one 30g biscuit fortified with Jaselor per day for 8 weeks. Biscuits are developed using the Standardized formulation to incorporate jagung bose, moringa leaves and fish flour that are high in iron, protein and key micronutrients. The study team selected and trained nutrition monitors from the community, who diligently monitored compliance and recorded the reasons for school absences on daily record sheets. The intervention and control groups were placed on different sides of the classroom to prevent peers from sharing cold beverages and biscuits. Children were not permitted to leave the classroom or go back to their original seats before they had consumed all of their beverages and cookies, and distribution and consumption were closely monitored. A brief questionnaire was used to gather data on breakfast and snacking habits during the school day, as well as the acceptance of the biscuits and cold beverages, at the baseline and 6- and 12-month evaluations.

Data Collection (Anthropometric measurements and Blood sampling and analysis)

Anthropometric measurements were carried out at baseline and at the end of the study. All anthropometric measurements were taken in duplicates and the mean

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calculated. Nutritional status: Weight-for-age (WAZ), height-for-age (HAZ), and weight-for-height (WHZ) Z-scores were computed according to United States growth standards[26]. A Seca 214 stadiometer was used to measure height to the closest 0.1 cm. The Omron body composition monitor (Model HBF-514) was used to measure weight to the closest 0.1 kg. WHO AnthroPlus version 1.0 was used to generate the height-for-age (HAZ), weight-for-age (WAZ), and BMI-for-age (BAZ) z-scores.4. According to the WHO median for WAZ, HAZ, and BAZ, children below negative two standard deviations (−2SD) were classified as underweight, stunted, or thin/wasted, respectively. Z-scores greater than or equal to -2SD were considered normal. 5ml venous blood was drawn from the study participants. 2ml of the blood was put into EDTA (Ethylene diamine tetra acetic acid) tubes to be used for hematological analysis using the Mindray Auto Hematological Analyzer (Model: BC-3000Plus, Germany). 3ml was placed in a serum separator tube to clot. In the laboratory the tube was centrifuged for 15 minutes for 4,000 rpm. The serum was subsequently aliquoted into micro tubes and stored at -80oC until they were analyzed. Human C-reactive protein Enzyme-Linked Immunosorbent Assay (ELISA) test kit (Catalogue number: JL-F46268) was used for C-reactive protein (CRP) analysis. Anemia was defined as hemoglobin concentration <11. 5 g/dL. Total Plate Count (TPC) analysis was conducted to determine the total viable aerobic microorganisms in fortified Jaselor biscuits and to assess microbiological quality in accordance with BPOM standards. Approximately 10 g of each sample was aseptically homogenized in 90 mL of sterile diluent, followed by serial decimal dilutions. Aliquots (1 mL) from appropriate dilutions were plated on Plate Count Agar using the pour plate method and incubated at 35–37°C for 48 h under aerobic conditions. Colonies were counted on plates containing 30–300 colonies, and results were expressed as colony-forming units per gram (CFU/g). The obtained values were compared with BPOM limits (m = 10^4 CFU/g; M = 10^5 CFU/g.

Statistical Analysis

Data Analysis SPSS was used to analyze the data. In-group comparison between pre- and post-intervention values was performed using paired t-tests. Samples t-tests were used to determine statistical significance for the group differences of continuous variables at baseline and at endline. Paired t-tests were used to determine significant mean differences within each group before and after the intervention. Binary logistic regression analysis was performed to determine the effect of intervention or group type on iron deficiency, anemia and cognitive test scores at the end of the intervention. P value < 0.05 was considered statistically significant Differences between groups were compared using independent t-tests. Statistical significance was defined as $p < 0.05$.

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Ethical Consideration

The study was approved by the relevant Health Research Ethics Committee 00138/KEPK FKM UNDANA/2024. Informed consent was obtained from all caregivers prior to participation.

RESULTS AND DISCUSSION

Table 1 shows the nutritional composition of Jaselor biscuits that shows the product has the potential to positively impact the diet of under-five children in the dryland areas of Nusa Tenggara Timur. The biscuits also have a high energy density which is relevant for children more at risk of not having sufficient energy intake due to food insecurity as energy is one of the most important nutrients. The biscuits have a protein content that will help in the growth and repair of body tissues which is important for many resources poor countries that lack the availability of animal protein. Fortified biscuits will help in the management of under-nutrition in a population however to also help eliminate stunting the population also requires of sustained protein supplementation to be able to help in progressing any improvements of height in the short to medium term. The addition of iron into the Jaselor biscuits is critical due to the high incidence of anemia in children under five years of age in the area of the study. Even though there is ample inclusion of iron in the biscuits to increase the intake of dietary iron, there are many factors that influence the iron status of an individual such as the absorbability of iron, the presence of dietary factors that inhibit absorption, and the frequency of consumption and in this region of NTT the diet is mostly composed of plants which are the cause of high iron absorption and as a result of this, the body iron is low. In summary, we can say fortified Jaselor biscuits can be integrated into nutrition programs but cannot be a singular solution to improving the nutrition status of children. The highest protein content was observed in product P1 (14.77±2.10%), followed by P2 (13.34±1.10%), P3 (9.64±0.9%), and the lowest in P4 (9.06±0.6%). Carbohydrate content was highest in P4 (39.27±0.91%), followed by P3 (38.46±1.02%), P2(35.93±1.12%), and lowest in P1 (30.36±1.3%). Fat content was also highest in P1 (23.02±1.12%) and lowest in P4 (18.21±0.8%). Iron (Fe) content varied, with the highest value in P1 (2.41±1.7 mg) and the lowest in P4 (1.46±0.91 mg). The highest energy value was found in P1 (560±1.02 kcal) and the lowest in P4 (448±1.2 kcal). Current findings show that there are significant differences in the macronutrient composition, micronutrient content, and energy density of the various fortified Jaselor biscuit formulations. For instance, among all other treatments, P1 had the highest values of protein (14.77 ± 2.10%), fat (23.02 ± 1.12%), and energy value (560 ± 1.02 kcal) and also had the highest value of iron (2.41 ± 1.7 mg), while P4 had the least values for all these parameters. Such differences have implications for the nutritional needs of people, and in particular under-five children in dryland areas, where the energy

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and micronutrient intake are often deficient. The findings from P1 are also consistent with the findings of studies involving fortified complementary foods in the low-and-middle income countries, that have shown that protein adequacy is one of the most important nutritional determinants for the positive growth and weight gain of children. Overall, the superior nutritional profile of P1—characterized by higher protein, fat, iron, and energy content—positions this formulation as the most promising candidate for supplementary feeding interventions targeting under-five children in dryland regions. These findings are consistent with global research emphasizing that the effectiveness of fortified foods depends not only on micronutrient fortification but also on overall macronutrient balance and energy density. When combined with acceptable sensory properties and microbiological safety, as demonstrated in this study, formulations such as P1 have strong potential to contribute to improved nutritional and iron status among vulnerable child populations.

Table 2 shows the results of the microbiological tests conducted on fortified Jaselor biscuits. The total plate count (TPC) for all treatments—P1, P2, P3, and P4—were 1.8×10^3, 1.25×10^3, 1×10^3, and 0.8×10^3 colony/g, respectively. All of these values are well below the maximum limit set by the Indonesian National Standard (SNI) and the National Agency of Drug and Food Control (BPOM), which is 1.8×10^4 colony/g. This indicates that all Jaselor biscuit products are microbiologically safe for consumption and comply with food safety standards. The results confirm that the preparation and storage processes for Jaselor biscuits are adequate in terms of food safety, making these biscuits a viable alternative as a nutritious supplementary food for young children.

Sensory Acceptance Test Results for Jaselor Flour, Fish Flour, and Sorghum Flour Noodles. The results of the sensory acceptance test for noodles made from corn bose flour, moringa leaf flour, fish flour, and sorghum flour are presented in Table 3. The scores for color, taste, aroma, texture, and overall acceptability of the biscuits range as follows: Color: .91–3.17; Taste: 4.80–2.51; Aroma: 4.85–2.87; Texture: 4.87–2.58; Overall Acceptability: 4.89–3.31. Biscuits made from 100% wheat flour had significantly higher sensory acceptability scores ($p < 0.05$) compared to biscuits containing 5%, 10%, 15%, or 20% moringa leaf flour. The findings indicate that color, taste, aroma, texture, and overall acceptability of the noodles decreased significantly ($p < 0.05$) as the concentration of moringa increased [27]. The lower sensory acceptance could be attributed to the following factors: Green Color: The green color of moringa leaf powder affects the appearance of the product. Bitter Taste: The bitterness of moringa is not well received by consumers, who are accustomed to the typical color and flavor of conventional noodles. As noted by name of author [28], products supplemented with moringa tend to have a bitter taste and greenish hue, which negatively impacts their sensory acceptability in terms of taste and aroma as

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the concentration of moringa increases. The lower texture score may result from the use of fine moringa leaf powder, which is made from leaves and has a unique consistency. This observation aligns with findings from Awobusuyi who reported similar results incomparable studies [29].

The contribution of Jaselor fortified biscuits to the recommended dietary allowance (RDA) for children aged 6 months to 3 years in Table 4 indicates that each serving of Jaselor biscuits provides 3.15 grams of protein, which accounts for 15.75% of the daily protein requirement for this age group. The carbohydrate content per serving is 15.46 grams, contributing 7.19% to the RDA, while the fat content is 3.67 grams, equivalent to 8.15% of the RDA. Each serving also supplies 2.15 mg of iron, fulfilling 11.75% of the daily iron requirement. Notably, the energy provided per serving is 657.17 kcal, covering 48.68% of the RDA for energy in children aged 6 months–3 years. These findings highlight that Jaselor fortified biscuits make a substantial contribution to the daily nutritional needs of young children, particularly as a supplementary food in regions at risk for undernutrition.

The results of body weight measurements in children underfives who were given Jaselor fortified biscuits are indicated in Table 5. The mean initial body weight was 8.997± 1.357 kg, which increased to a mean final body weight of 10.126 ± 1.676 kg after the intervention. This reflects an average weight gain of 1.448 ± 0.81 kg over the study period. The minimum and maximum values show a starting weight range from 7.208 kg to 12.908 kg, with final weights ranging from 7.206 kg to 14.673 kg. The smallest recorded weight gain was 0.002 kg, while the highest was 1.765 kg. These results indicate that consumption of Jaselor fortified biscuits was associated with a notable improvement in body weight among children under five, suggesting a positive impact on their nutritional status.

Table 6 reports the results of hemoglobin level measurements in children under five who were given Jaselor fortified biscuits. The mean initial hemoglobin (Hb) level was 9.677 ± 0.786 g/dL, which increased to a mean final value of 10.566 ± 1.856 g/dL following the intervention. This corresponds to an average increase in hemoglobin of 2.432 ± 0.576 g/dL. The minimum recorded initial Hb level was 10.277 g/dL, increasing to a minimum post-intervention value of 11.133 g/dL, with the minimum increase being 0.856 g/dL. The maximum initial Hb level was 10.463 g/dL, with a maximum final value of 12.422 g/dL and the greatest observed increase was 1.959 g/dL. These findings indicate that the consumption of Jaselor fortified biscuits led to a notable improvement in hemoglobin levels among the children, supporting the effectiveness of this intervention to address anemia in young children.

Table 7 presents a comparison of weight gain in children under five before and after receiving supplementary feeding (PMT) with Jaselor biscuits. The intervention group

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experienced a mean weight gain of 3.911 ± 0.765 kg, significantly higher than the control group, which showed a mean gain of 1.143 ±0.211 kg. The difference in mean weight gain between the two groups (Δ Mean) was 3.2 kg, with a 95% confidence interval (CI) ranging from -1.145 to 0.412, and a p-value of 0.001, indicating statistical significance. These results demonstrate that supplementation with Jaselor fortified biscuits led to a markedly greater increase in body weight among children, highlighting the effectiveness of the intervention in improving the nutritional status of under-five children.

The results of increased hemoglobin (Hb) levels in children under five before and after supplementary feeding (PMT) with Jaselor biscuits in table 8 show that the intervention group demonstrated a mean increase in Hb level of 2.432 ± 0.576 g/dL, which was significantly higher than the control group's mean increase of 1.831 ± 0.173 g/dL. The difference in mean increase (Δ Mean) between the groups was 3.4 g/dL, with a 95% confidence interval (CI) ranging from -1.159 to - 0.591 and a p-value of 0.000, indicating a statistically significant improvement. These findings highlight that the supplementation with Jaselor fortified biscuits effectively raised hemoglobin levels among children under five, supporting its potential as an intervention for anemia prevention in this vulnerable population.

The results data also show a tendency for increased protein and carbohydrates in biscuit Types P1, P2, P3, and P4, namely the greater the substitution of Jaselor flour, the greater the protein and carbohydrate content, while this is the opposite of the types biscuits Jaselor, the less substitution of Jaselor flour, the greater the protein and carbohydrate content contained in it biscuits [30]. This can also be caused by the wheat flour used being fortified flour. Laboratory test data shows that 100 grams of biscuits contain as much as 15,870 vitamin A, so that consuming three biscuits every day is enough to meet daily vitamin A needs. In addition, it also contains fiber, protein, carbohydrates, and fat [25]. Thus, fortification of moringa leaves can increase the nutritional value of biscuits which can be a snack that provides vitamin A to support the additional food program (PMT) for Children Under five years old [20]. The results of the analysis of variance showed that the treatment of adding flour would have a very significant effect (α = 0.01) but the treatment of storage time and the interaction between the two treatments did not have a significant effect (α = 0.05) on the protein content of biscuits. This means that the protein content of P1 biscuits is higher than that of P4 biscuits. The cause of the high protein content is because there are basic ingredients of jaselor flour (corn, green beans, peanuts, coconut milk), anchovy flour which has a very high protein content (89.26% bk). While there is no significant difference in protein levels during storage because the packaging used is able to protect the protein from damage due to light, oxidation or other damage [30]. The protein content of P4 biscuits is lower than the SNI No. 01- 2973-

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92 standard, which is a minimum of 9.06% while P4 biscuits have met SNI requirements. When compared to the adequacy of protein for pregnant women of 60 g/person/per day then to meet the sufficiency a mother must consume 304.11 g of biscuits per day or 51 - 52 pieces [31].

Based on the table 2 microbiological test results, the fortified Jaselor biscuits meet the microbiological safety standards set by BPOM. Total microbial count for all treatments (P1-P4) is below the maximum allowable (+/- 10, 000 colonies/g; - 10, 000 colonies/g) and none of the treatments is above the maximum allowable. This also shows that the fortification of biscuits was not detrimental to the biscuits' microbiological quality and that production was done under proper hygienic conditions. Also, the low microbial count, especially in treatment P4, is probably due to the low moisture, which aids in the proper baking conditions and is known to prevent microbial growth in baked goods. Because children under five years are most susceptible to foodborne illnesses, the fortified Jaselor biscuits are microbiologically safe for use as food supplementation of children under five years in the drylands of Nusa Tenggara Timur, as long as the biscuits are processed and stored under controlled conditions. This is because the average protein content of biscuits is 19.73%. The method of microbiological testing of food samples is the TPC test (Total Plate Count) to count bacteria, Most Probable Number (MPN) to calculate the number of Escherichia coli, Salmonella sp., and cup count to calculate the number of Staphylococcus sp. and mold/yeast. Data analysis refers to food requirements that have been set according to the Indonesian National Standard (SNI 01-2897-1992). The results of the study showed that microbial testing of flour biscuits Normal jaselor does not exceed the provisions of the Indonesian National Standard (SNI) which requires a maximum of 1.8x104colonies/g of bacteria [32]. Test Salmonella sp. negative results were obtained. The results of the pregnancy test E. coli less than 3/g. Content test result Staphylococcus aureus much as <1.0x101colonies/g. The result of the mold/yeast count test is less than 1.0x101colony/g. The conclusion of the microbiological identification results of banana peel flour biscuits is stated in the normal category according to the National Standard Indonesia and BPOM (PPOMN No.43/M/14)), so that it can be consumed by the public as health food [21]. The acceptability test results in Table 3 show statistically significant differences in sensory attributes among the fortified Jaselor biscuit formulations, as indicated by different superscript letters ($p < 0.05$). Product P1 consistently received higher scores for texture, aroma, colour, taste, and overall quality, with superscripts differing from those of P2, P3, and P4. This indicates that P1 was significantly more acceptable to under-five children than the other formulations. From a practical perspective, these statistical differences suggest that children were more willing to consume P1 compared to biscuits with lower acceptance scores. Texture and taste, which showed significant differences across

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SCHOLARLY, PEER REVIEWED
Volume 26 No. 4
April 2026
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ISSN 1684 5374

treatments, are particularly critical for young children, as these attributes directly influence chewing ability and willingness to eat. The lower acceptance scores observed for P4, which were statistically different from P1, imply a higher likelihood of rejection or reduced intake, potentially limiting its effectiveness as a supplementary food despite its nutritional value. The moderate acceptance scores of P2 and P3, which did not consistently differ from P1 across all sensory attributes, suggest that certain levels or combinations of fortification can still maintain acceptable sensory quality. These findings highlight the importance of using statistical differences not only to demonstrate variation among formulations but also to guide the selection of products that balance nutritional enhancement with practical acceptability. In this context, formulations with significantly higher acceptance scores, such as P1, are more likely to achieve consistent consumption and, consequently, a greater nutritional impact in under-five children. The results indicate that one serving of Jaselor-fortified biscuits contributes meaningfully to the daily energy and nutrient requirements of children aged 6–36 months. The product provides nearly half of the daily energy requirement (48.68% RDA), highlighting its suitability as an energy-dense supplementary food for young children with limited gastric capacity, a characteristic widely recommended for complementary and therapeutic foods in food-insecure settings. Protein contribution (15.75% RDA) suggests a moderate but relevant role in supporting growth and tissue maintenance, particularly when the biscuits are consumed alongside household foods. This level of protein contribution is comparable to other fortified complementary foods reported globally, which are designed to complement rather than replace habitual diets. Fat contribution (8.15% RDA) further enhances energy density and may support the absorption of fat-soluble nutrients, consistent with international recommendations for foods targeting early childhood nutrition. Iron contribution reached 11.75% of the RDA, indicating potential benefits for improving dietary iron intake in populations at risk of iron deficiency anemia. Although this contribution alone is unlikely to meet total iron requirements, regular consumption, combined with other iron sources or fortification strategies, may support improved iron status. Carbohydrate contribution (7.19% RDA) reflects a balanced macronutrient profile, avoiding excessive reliance on carbohydrates while maintaining adequate energy provision.

These findings suggest that Jaselor-fortified biscuit is a promising intervention using local available ingredients (mixture of jagung bose, daun kelor, and fish flour) to enhance under-five children's hemoglobin status in dry land [33]. Children in arid, food-insecure areas such as East Nusa Tenggara tend to suffer from all types of malnutrition, marked by chronic undernutrition and anemia partly because of low access to varied, nutrient-dense foods. The problem is being addressed through some of the local food sources such as moringa leaves and fish flour which is very culturally acceptable, inexpensive, and high in nutrition [34]. The intervention group

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SCHOLARLY, PEER REVIEWED
Volume 26 No. 4
April 2026
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

had a noteworthy rise in hemoglobin thanks to the consumption of fortified biscuits. The iron levels of moringa leaves and fish flour account for the improvement [35]. The level of moringa non-heme iron content is also significant, with Vitamin C for its better absorption. With the provision of heme iron and essential amino acids accountable for hematopoiesis, fish flour provides an additional source. The results build on previous research confirming moringa's efficacy as an anti-anemic agent in undernourished communities. Aside from their role in the reduction of anemia, the biscuits also had beneficial effects on the weight-for-age and height-for-age measures among the children. Daun kelor and jagung bose leaves provide vital fibers and micronutrients, whereas the protein and lipid profiles of fish flour cater to both acute and chronic malnutrition statuses. The findings refer to the likelihood that Jaselor biscuits can serve as a very much needed complementary feeding alternative, particularly in regions. overwhelmed by low household incomes and dietary diversity constraints.

The results show that children receiving Jaselor-fortified biscuits experienced meaningful improvements in both body weight and hemoglobin levels over the intervention period. Mean body weight increased from 8.997 ± 1.357 kg at baseline to 10.126 ± 1.676 kg at endline, corresponding to an average weight gain of 1.448 ± 0.81 kg. This magnitude of weight gain suggests a positive response to the intervention and indicates that the fortified biscuits provided sufficient additional energy and nutrients to support short-term growth in under-five children, particularly in settings where baseline dietary intake is often inadequate. In parallel, hemoglobin concentrations increased from 9.677 ± 0.786 g/dL at baseline to 10.566 ± 1.856 g/dL at endline, with a mean increase of 2.432 ± 0.576 g/dL. This improvement is nutritionally and clinically relevant, given that baseline hemoglobin values indicate a high prevalence of anemia among the children. The observed increase in hemoglobin suggests that the iron provided through the fortified biscuits contributed to improved iron status, consistent with evidence from other fortified complementary food interventions targeting young children in resource-limited settings. Taken together, the concurrent improvements in body weight and hemoglobin highlight the dual benefit of Jaselor-fortified biscuits in addressing both energy–protein inadequacy and micronutrient deficiency. These findings support the use of the fortified biscuits as an effective supplementary food for under-five children, particularly in dryland regions where food insecurity and anemia are prevalent. However, sustained improvements in growth and anemia reduction are likely to require continued consumption of fortified foods alongside broader interventions addressing diet diversity, infection control, and child-care practices.

In table 6 results demonstrate a significantly greater increase in hemoglobin levels among children who received PMT Jaselor compared with the control group. The

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SCHOLARLY, PEER REVIEWED
Volume 26 No. 4
April 2026
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ISSN 1684 5374

mean increase in hemoglobin concentration in the intervention group (2.432 ± 0.576 g/dL) was substantially higher than that observed in the control group (1.831 ± 0.173 g/dL), with the difference being statistically significant ($p < 0.001$). This finding indicates that PMT Jaselor had a measurable and positive effect on improving hemoglobin levels in under-five children. The observed mean difference (Δ mean = 3.4 g/dL) and the corresponding 95% confidence interval further support the robustness of the intervention effect. These results are nutritionally meaningful, particularly given the high baseline prevalence of anemia in young children in food-insecure settings. Similar improvements in hemoglobin levels have been reported in studies evaluating fortified supplementary foods and iron-fortified products for under-five children, suggesting that PMT Jaselor is comparable in effectiveness to globally recognized interventions.

Dryland Characteristics: NTT experiences low agricultural productivity due to arid conditions, leading to limited availability of diverse, nutrient-rich foods [36]. Prevalence of Malnutrition of Stunting, wasting, and anemia are highly prevalent among children under five in the region due to insufficient dietary diversity and poor nutrient intake [37]. Traditional and locally available ingredients like jagung bose and moringa leaves can be leveraged to create accessible, nutrient-dense food products [38]. Moringa leaves are rich in iron, vitamin A, and other micronutrients critical for addressing anemia [39]. Studies suggest that fortified products containing moringa effectively increase hemoglobin levels by improving iron bioavailability [40]. Mechanism of Action: Vitamin A enhances iron absorption, while moringa's phytochemicals contribute to hematopoiesis (bloodcell production) [41]. Fortified biscuits showed significant improvements in hemoglobin levels among children under five, reducing anemia prevalence [42]. Macronutrient Contribution from Jagung Bose. The inclusion of corn as a base ingredient provides energy and essential macronutrients, crucial for growth in undernourished children. Moringa enhances the micronutrient profile, contributing to the alleviation of stunting and wasting [43, 44]. Weight and Height Gains [45]. Consuming fortified biscuits was associated with improved weight-for-height (wasting) and height-for-age (stunting) scores over time. The culturally appropriate formulation of Jaselor increases community acceptance and ensures the feasibility of long-term nutritional programs. Fortified biscuits are a cost- effective strategy to combat malnutrition and anemia in resource-limited settings [46]. The use of locally sourced ingredients promotes sustainability and scalability in similar dryland regions. Integrating fortified food products like Jaselor into government nutrition programs can enhance their impact on public health in underserved communities [47]. It also promotes sustainability and encourages acceptance by the broader community. The inclusion of local foods such as jagung bose in child feeding programs ensures compliance and enables long-term adoption, as these foods are already integrated into the local diet. Fortification

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SCHOLARLY, PEER REVIEWED
Volume 26 No. 4
April 2026
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ISSN 1684 5374

of biscuits with Jaselor is a feasible and cost-effective sustainable nutrition solution for anemia and malnutrition prevention in children under the age of five years in arid regions, such as NTT. Use of locally accessible ingredients makes them more suitable for community-based health programs in such contexts.

CONCLUSION AND RECOMMENDATIONS FOR DEVELOPMENT

Children under five in dryland Nusa Tenggara Timur, Indonesia, showed notably better hemoglobin levels and nutritional status from fortified biscuits made with Jaselor. A combination of jagung bose, moringa leaves, and fish flour. Children in the intervention group showed appreciable increases in hemoglobin and improvements in weight-for-age, height-for-age, and weight-for-height scores following 8 weeks of daily supplementation. This suggests that a locally based, efficient intervention to lower anemia and undernutrition in underprivileged groups is Jaselor-fortified biscuits. By leveraging local food resources and addressing specific nutritional deficiencies, such initiatives can make a significant contribution to reducing the burden of malnutrition and anemia in resource-constrained, dryland regions. However, the absence of a control group limits the ability to attribute observed improvements solely to the intervention. Future studies incorporating a controlled experimental design, larger sample sizes, and longer intervention periods are recommended to strengthen the evidence regarding the effectiveness of fortified Jaselor biscuits in improving child nutritional outcomes. In the dryland regions of NTT, Jaselor biscuits were very well accepted. The anthropometric measurements of the respondents were stabilized and/or improved by consuming Jaselor biscuits. Thus, during the dryland's "nutritional crisis," Jaselor biscuits may be an effective cure for wasting and stunting. The biscuits fortified with iron and the high nutritional value of natural iron from Moringa led to a significant increase in hemoglobin level in study subjects. Jaselor biscuits showed significant success in treating anemia, which has been growing at alarming levels in the dryland areas. Additional recommendations that can be utilized in order to broaden and augment the Jaselor.

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Author Contributions

- Anna Henny Talahatu: Conceptualization, Methodology, Writing – Original Draft.
- Marselinus Laganur: Data Collection, Review & Editing, Visualization, Supervision,
- Grouse Oematan: Analysis, Writing, Funding Acquisition, Resources, Supervision.

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SCHOLARLY, PEER REVIEWED
Volume 26 No. 4
April 2026
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DECLARATION OF COMPETING INTERESTS

The authors declare no conflict of interest.

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SCHOLARLY, PEER REVIEWED
Volume 26 No. 4
April 2026
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Table 1: The results of the analysis of the nutritional content on Fortification

Product	Protein	Carbohydrate	Fat	Fe	Energy
P1	14.77±2.10^{ac}	30,36±1,3^{b}	23,02±1,12^{ac}	2,41±1,7^{ab}	560±1.02^{ac}
P2	13,34±1,10^{ab}	35,93±1,12^{c}	21,07±0,9^{ab}	2,01±1,51^{ac}	524±1,1^{ab}
P3	9,64±0,9^{a}	38,46±1,02^{ab}	19,15±1,01^{b}	1,78±1,03^{b}	478±0,9^{a}
P4	9,06±0,6^{b}	39,27±0,91^{ac}	18,21±0,8^{b}	1,46±0,91^{a}	448±1,2^{a}

Jaselor Biscuits

** Superscript letters (a, b, c) significant differences ($p < 0.05$), superscript letters ab, ac, not significant

Table 2: Microbiological Test Results on Fortification of Jaselor Biscuits

No.	Treatment	Test Number Total Plate	BPOM No.13 2019	Description
1	P1	1.8 x 10^3 colony /g		
2	P2	1.25 x 10^3 colony /g	N=5; c=2	Eligble
3	P3	1x 10^3 colony /g	colonies/g;	
4	P4	0.8 x 10^3 colony /g	colony/g	

N, c, m, and M: microbiological acceptance criteria based on BPOM standards. N: number of sample units tested; c denotes the maximum allowable number of sample units with microbial counts between m and M; m is the microbiological limit below; and M is the maximum

Table 3: Average acceptance test results and quality of fortification Jaselor Biscuits

Product	Organoleptic test components				
	Texture	Appetizing	Colour	Taste	Quality
P1	3,70±1.2^{ab}	3,70±0,11^{ac}	3,22±1.3^{ab}	4±1.17^{ac}	3,74±1.5^{ab}
P2	2,48±1^{b}	2,74±1.1^{b}	2,70±1.21^{ac}	2.91±1.01^{ab}	2,74±1.3^{a}
P3	2,65±0,9^{a}	2,87±1.02^{a}	2,74±1.17^{b}	3.30±1.07^{a}	2,78±1.03^{a}
P4	2,00±1.1^{c}	2,26±1^{c}	2,00±1.02^{a}	2,52±1.05^{b}	1,91±1^{b}

Superscript letters (a, b, c) significant differences ($p < 0.05$), superscript letters ab, ac, not significant

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SCHOLARLY, PEER REVIEWED
Volume 26 No. 4
April 2026
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Table 4: Contribution of the Nutritional content of "Jaselor fortified" local therapeutic food biscuits

Nutrient	Nutritional content per serving	RDA (6–36 months)	Contribution to RDA (%)
Protein (g)	3,15	20	15,75
Carbohydrate (g)	15,46	215	7,19
Fat (g)	3,67	45	8,15
Fe (mg)	2,15	18,3	11,75
Energy (kcal)	657,17	1350	48,68

Table 5. Effects of Jaselor-Fortified Biscuit Intervention on Body Weight and Hemoglobin Levels of Under-five years

Outcome	Time / Group	Mean ± SD	Minimum	Maximum
	Baseline	8.997 ± 1.357	7.208	12.908
Body weight (kg)	Endline	10.126 ±1.676	7.206	14.673
	Weight gain	1.448 ± 0.81	0.002	1.765
	Baseline	9.677 ± 0.786	10.277	10.463
Hemoglobin (g/dL)	Endline	10.566 ±1.856	11.133	12.422
	Hb increase	2.432 ± 0.576	0.856	1.959

Table 6: The results of measuring Increased Hb Levels in Children Under five years old Before and After PMT Jaselor

Variable	Mean ± 2SD		p	Δ Mean	Δ CI 95%
	Baseline	Endline			
Hb Level	1,831±0,173	2,432 ± 0,576	0,000	3,4	(-1,159)-0,591

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April 2026
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