

Acceptability Test and Nutritional Analysis of Tempeh and Moringa Leaf Soft Rice as Complementary Foods (MP-ASI)

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ABSTRACT

The age of 6–24 months is a crucial period for a child's growth and development, requiring optimal nutritional intake through the provision of Complementary Foods (MP-ASI). MP-ASI serves to supplement nutritional needs that can no longer be met by breast milk alone. Tempeh, as a source of plant-based protein, and moringa leaves, which are rich in iron and vitamins, have the potential to be developed into "nasi tim" (soft rice) as recommended by WHO. This study aims to assess the acceptability and analyze the nutritional content of tempeh and moringa leaf soft rice as a complementary food. The study used a non-factorial Completely Randomized Design (CRD) with three formulations: F1 (10% tempeh: 15% moringa leaves), F2 (20%: 10%), and F3 (30%: 15%). The acceptability test was conducted on 30 semi-trained panelists using a hedonic test for taste, color, aroma, and texture attributes, which were then analyzed using the Kruskal–Wallis test. The results showed significant differences in taste ($p=0.00$) and aroma ($p=0.01$), while color ($p=0.08$) and texture ($p=0.01$) did not differ significantly. Formulation F3 had the highest acceptability level, containing 75.38 kcal/100 g of energy, 3.55% protein, 15.36% carbohydrates, 0.12% fat, 1.46% crude fiber, and 0.92 mg/100 g of iron.

Keywords: Complementary Feeding, Rice Porridge, Tempeh, Moringa Leaves

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1. INTRODUCTION

The period from 6 to 24 months is a critical phase for a child's growth and development. Complementary Feeding (CF/MP-ASI) consists of food and beverages containing essential nutrients provided to infants or children aged 6–24 months to meet nutritional requirements beyond breast milk [1]. The introduction and administration of complementary foods must be conducted gradually, with both the form and quantity adjusted to the infant's digestive capacity. Feeding practices and the ingredients used should vary from liquid or thin porridge to thick porridge, fruit juice, fresh fruit, pureed food, soft food, and eventually solid food [2]. Inappropriate food consumption can lead to growth disturbances and nutritional deficiencies. Furthermore, premature introduction of MP-ASI can cause health problems in children. One health issue that requires serious attention is stunting. The World Health Organization (WHO) defines stunting as a height-for-age (H/A) Z-score of < -2 standard deviations (SD). Globally, approximately one in four toddlers is stunted. Stunting is frequently observed in children aged 6–11 and 12–17 months, with a prevalence of 38.5% [3].

Moringa leaves (*Moringa oleifera*) represent a potential alternative for meeting children's nutritional needs, as they provide approximately 14 calories and nutrients such as carbohydrates, protein, iron, potassium, magnesium, vitamin C, vitamin A, calcium, and folic acid. Additionally, they contain fiber, vitamin B, phosphorus, copper, zinc, and selenium. Compared with spinach, moringa leaves contain significantly higher levels of iron [4]. Research indicates that the iron content in 100 g of moringa leaves ranges from 8.3 to 110 mg. In comparison, spinach contains only 32 mg/100 g, and katuk leaves contain 3.1 mg [4], [5]. The iron content in moringa leaves exhibits high variability (8.3 to 110 mg/100 g); however, the high concentrations make it a potent source for meeting the body's iron requirements. The daily iron requirement for infants aged 7–12 months is 11 mg, while children aged 1–3 years require 7 mg, and those aged 4–8 years require 10 mg [6].

Tempeh is a local food source with the potential to be used in MP-ASI. Utilizing tempeh as a base for MP-ASI not only helps fulfill an infant's protein requirements but also supports the use of accessible and affordable local foods [7]. Therefore, tempeh was selected as the primary ingredient in the formulation of tempeh and moringa leaf soft rice (nasi tim) in this study. Adequate protein intake assists children in achieving optimal growth, thereby reducing the risk of stunting [8]. The texture of the food must also be considered; research has shown a correlation between MP-ASI texture and the nutritional status of infants aged 6–12 months. First foods should have an easily digestible texture. Regarding feeding frequency, infants aged 6–8 months should be fed 2–3 times daily, those aged 9–11 months 3–4 times daily, and those aged 12–24 months 4–5 times daily [9]. This aligns with WHO guidelines recommending soft-textured foods to support optimal development. Stunting interventions are most effective before the age of 2 years, a crucial period of accelerated growth and a vital window to prevent physical and motor delays. Soft-textured foods, such as nasi tim, facilitate easier consumption by infants.

Based on the discussion regarding nutritional fulfillment during the growth period and the significant potential of local food sources, this study was conducted to develop an infant soft rice (nasi tim) formulation based on tempeh and moringa leaves as an alternative complementary food (MP-ASI) rich in protein and iron. The primary objective of this research was to analyze the nutritional content and panelist acceptability levels of the MP-ASI relative to the requirements of toddlers aged 9–11 months. It is expected that this research will provide significant benefits through the innovation of affordable functional food products for the community, aiding in stunting prevention and improving children's nutritional status by optimizing available local resources.

2. METHOD

The research design utilized a non-factorial completely randomized design (CRD) [10] with a single factor: the variation in the proportions of tempeh and moringa leaves. The three formulations were F1 (10%:15%), F2 (20%:10%), and F3 (30%:15%). This study aimed to determine the effects of these proportions on the acceptability and nutritional content of soft rice (nasi tim), specifically focusing on energy (kcal), carbohydrates (%), protein (%), fat (%), moisture content (%), ash content (%), crude fiber (%), and iron (mg). This research received ethical approval under number No.4819/KEP-UNISA/IX/2025. The three product formulations were developed using the specified ratios of tempeh and moringa leaves. Subsequently, the formulations underwent sensory evaluation for acceptability at the Sensory Testing Laboratory of Universitas ‘Aisyiyah Yogyakarta, while nutritional analysis was conducted at the CV. Chem-Mix Pratama Laboratory.

The independent variable in this study was the proportion of tempeh and moringa leaf formulation. The study involved 30 semi-trained panelists selected using purposive sampling. The inclusion criteria for panelists required students to have an understanding of sensory attribute evaluation, —including taste, color, aroma, and texture, —to ensure objective acceptability ratings. The exclusion criteria ensured that panelists were not suffering from sensory-related illnesses, such as the flu, coughs, colds, or sore throats, and had no known allergies to legumes (soybeans).

Table 1. Formulation Design

Ingredient	Formulation		
	F1	F2	F3
	10 % : 15 %	20 % : 10 %	30 % : 15 %
Nasi Tim (soft rice)	120 g	120 g	120 g
Tempe	12 g	24 g	36 g
Moringa leaf	6 g	12 g	18 g
garlic	10 g	10 g	10 g
Red onion	12 g	12 g	12 g
Salt	5 g	5 g	5 g
papper	3 g	3 g	3 g
Bay leaf	10 g	10 g	10 g
Leek	20 g	20g	20g
Chicken broth	50 ml	50 ml	50 ml

Tempeh and moringa leaf soft rice (nasi tim) was formulated in several variations with different proportions of tempeh and moringa leaves, as shown in Table 1. The main ingredients of the soft rice included rice, tempeh, moringa leaves, water, shallots, garlic, bay leaves, scallions, salt, pepper, and chicken stock. The preparation process involved washing the rice thoroughly and cooking it until it reached a soft consistency. The tempeh and moringa leaves were steamed and pureed, and all ingredients were mixed according to the formulations and steamed (ditim) until fully cooked with a soft texture.

Sensory evaluation was conducted in a specialized facility comprising a briefing room and a testing room with individual booths, involving 10 panelists per session across three sessions. Each panelist received a set of samples for each tested formulation along with a questionnaire. Primary data were obtained through an acceptability test using a five-point hedonic scale: 1 = strongly dislike, 2 = dislike, 3 = neutral/fairly like, 4 = like, and 5 = strongly like, covering the attributes of taste, color, aroma, and texture.

The results of the acceptability questionnaire (organoleptic test) were further processed using the Kruskal-Wallis test and the Mann Whitney U follow-up test using SPSS to determine the degree of significance. The soft rice sample

with the best formulation was analyzed for its nutritional content at the CV. Chem-Mix Pratama laboratory. The analysis employed the Kjeldahl method for protein content, the Soxhlet method for fat analysis, the drying oven method for moisture content, and the dry ashing method for ash content. Carbohydrates were calculated by difference, and atomic absorption spectrophotometry (AAS) was used to measure iron content. The nutritional content results were then analyzed descriptively.

3. RESULTS AND DISCUSSION

3.1. Respondent Characteristics

Table 2. Characteristics of respondents

Characteristics	Category	Amount (n)	Presentation (%)
Age	18-20 thn	13	43,3%
	21-22 thn	17	56,7%
Gender	Male	2	6,7%
	Female	28	93,3%
Total		30	100%

An organoleptic test is a method of food quality assessment that utilizes the human senses (sight, smell, taste, and touch). The panelists in this study were primarily aged 21–22 years, totaling 17 individuals (56.7%), and were predominantly female, accounting for 28 individuals (93.3%) out of a total of 30 panelists. This group was selected because young adults possess good sensory capabilities in distinguishing organoleptic attributes such as taste, color, aroma, and texture, making them suitable for evaluating the acceptability of tempeh and moringa leaf soft rice products.

3.2. Organoleptic Test

Table 3. Results of sensory evaluation analysis

Indicator	F1	F2	F3	P Value*
Flavor	2,70 ± 1,17 ^a	2,70 ± 1,06 ^a	3,97 ± 1,00 ^b	0,00
Color	2,77 ± 1,00 ^a	3,10 ± 1,18 ^{ab}	3,50 ± 0,97 ^b	0,08
Aroma	2,90 ± 0,90 ^a	3,17 ± 0,95 ^a	3,80 ± 1,10 ^b	0,01
Texture	3,03 ± 1,12 ^a	3,40 ± 1,00 ^a	3,53 ± 1,04 ^a	1,44

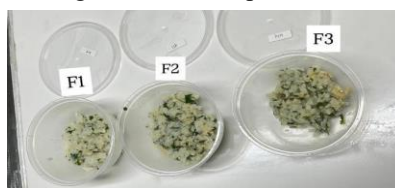
*) Note: Different letter notations (a, b) within the same row indicate a significant difference

3.2.1. Flavor

The evaluation of taste in tempeh and moringa leaf soft rice (nasi tim) indicated that panelist acceptance fell within the "fairly liked" category. Based on the organoleptic test results, F1 obtained an average score of 2.77, F2 scored 3.10, and the most preferred formulation was F3 with a score of 3.97. These values demonstrate that F3 had the highest level of taste acceptance compared to the other formulations. The Kruskal-Wallis test results showed a significant difference in the taste acceptance level across the formulations ($p = 0.00$). Formulation F3 had the highest average score and differed significantly from F1 and F2, while F1 and F2 showed no significant difference between each other. This indicates that F3 possessed a superior taste acceptance level. This preference occurred because the other formulations were perceived as less savory and dominated by the taste of rice, whereas the higher proportions of tempeh and moringa in F3 provided a more savory flavor profile. Specifically, the blend of tempeh and moringa leaves produced a savory taste that remained mild enough for infants and toddlers. These results align with research reporting that tempeh-based complementary foods have high taste acceptance [9]. This high acceptance is attributed to the use of tempeh, which has a savory flavor profile due to amino acids, particularly glutamate, known for providing a distinct umami (often described as meaty or savory) taste. This content increases through proteolysis (protein breakdown) during the tempeh fermentation process.

3.2.2. Color

Image 1. Team rice products



The organoleptic test results for color evaluation showed scores of 2.77 for F1, 3.10 for F2, and 3.50 for F3. Based on these results, F3 was identified as the best formulation preferred by the panelists, showing a significant difference compared to F1 ($p < 0.005$). However, the Kruskal-Wallis test results indicated that there was no statistically significant difference in the color parameter across all formulations ($p > 0.05$). Although there were variations in the

average color scores for each formulation, these differences were not statistically significant, suggesting that formulation variations did not exert a marked effect on the overall acceptance of the product's color. The higher score for F3 is attributed to the larger proportion of tempeh and moringa leaves, which created a more appealing appearance compared to the other formulations. The color of the soft rice tended to be green due to the addition of moringa leaves; as the proportion increased, the pigment content also increased, causing the final product to appear greener. The compounds responsible for the green color in moringa leaves are chlorophyll and carotenoid pigments [11]. Each formulation produced a distinct shade due to the different ratios of tempeh and moringa used; the light green hue of the moringa leaves blended with the pale color of the tempeh soft rice to produce an appearance that is quite attractive for baby food. Research by [12]. Research by [12] states that color is the first attribute observed and evaluated in food. If the color of the food is unappealing or deviates from expectations, consumers tend to be reluctant to consume it.

3.2.3. Aroma

The aroma of tempeh and moringa leaf soft rice (nasi tim) is characterized by a distinctive savory scent. The most preferred aroma was attributed to tempeh, as it provides a more savory fragrance that made panelists more interested in F3, which scored 3.80, followed by F2 at 3.17 and F1 at 2.90. Formulation F3 outperformed the other formulations because of its higher proportion of tempeh and moringa leaves, resulting in a more savory aroma. The resulting aroma must be mild, non-pungent, and free of off-odors that could decrease consumption interest. Statistical analysis showed a significant difference in the aroma parameter across the soft rice formulations ($p= 0.01$). Formulation F3 had the highest average score and was significantly different from F1 and F2, whereas there was no significant difference between F1 and F2. This indicates that variations in the formulation significantly influence the product's aroma acceptance level. As a complementary food (MP-ASI) product, aroma plays a vital role in creating a comfortable eating experience for infants, as strong scents can affect taste perception. The aroma assessment results help determine whether the formulation and processing methods have produced a scent that is well-received by panelists. Strong or dominant aromas are often inconsistent with the sensory preferences of toddlers or panelists, as children tend to prefer milder and more familiar scents. Several organoleptic studies on food products indicate that balanced or subtle aromas are better accepted by panelists, while overpowering or unusual scents decrease the overall preference for the product. Therefore, an MP-ASI formulation that produces an unfamiliar or overly dominant aroma may reduce acceptance by toddlers, even if other aspects such as taste and texture are appropriate [13].

3.2.4. Texture

The tempeh and moringa leaf soft rice generally has a smooth texture, consistent with standard nasi tim. Fundamentally, the texture of this product falls within the soft, tender, and easily mashable category. This is due to the processing method, which utilizes excess water during cooking to produce a moist rice matrix that is easy to chew. Based on the organoleptic test results, F1, F2, and F3 obtained scores of 3.03, 3.40, and 3.53, respectively. Regarding the texture attribute, there was no significant difference in the acceptance of the soft rice texture across the formulations ($p > 0.05$). All formulations showed relatively similar levels of texture acceptance, indicating that variations in ingredient composition did not exert a marked effect on the product's textural characteristics. It was observed that F3 achieved the highest score among the three formulations. The addition of mashed tempeh actually assisted in creating a more tender and compact texture, as the hydrolyzed tempeh protein during heating produced a soft structure that blended seamlessly with the rice porridge [14]. Moringa leaves, added in finely sliced or pureed form, did not hinder the softness; instead, the fine moringa fibers provided a gentle thickening effect without making the mixture coarse. Consequently, the consistency remains appropriate for complementary foods (MP-ASI), which require an easy-to-swallow consistency. Research on moringa-based soft rice indicates that moringa leaves do not significantly alter the texture and consistently produce food with a soft consistency [15]. The lack of significant difference across the three formulations is attributed to the uniform water-to-rice ratio used in each, resulting in a relatively consistent level of softness and density throughout the cooking process.

3.3. Nutritional Analysis

3.3.1. Energy

Table 4. Nutritional content per 100 g of tempeh and Moringa leaf soft rice

Zat Gizi	Nilai rata-rata (Mean \pm SD)
Energi (kkal)	75,38 \pm 0,09
Karbohidrat (%)	15,36 \pm 0,25
Protein (%)	3,55 \pm 0,21
Lemak (%)	0,12 \pm 0,02
Kadar air (%)	79,94 \pm 0,00
Kadar abu (%)	1,04 \pm 0,02
Serat kasar (%)	1,46 \pm 0,07
Zat besi (mg)	0,92 \pm 0,07

The energy value of soft rice (*nasi tim*) is 75.37 kcal/100 g. This energy value is influenced by the composition of carbohydrates, proteins, and fats. Energy content is a product of the metabolism of these three macronutrients and functions as fuel for metabolic processes [16]. When compared with the Recommended Dietary Allowance (RDA) based on the Regulation of the Minister of Health of the Republic of Indonesia Number 28 of 2019, the energy requirement for infants aged 9–11 months is 800 kcal per day. The energy content of the F3 formulation (75.38 kcal/100 g) contributes approximately 9.4% to the daily energy needs of infants in this age group. Consequently, although soft rice contributes to energy fulfillment as a complementary food (MP-ASI), it does not meet the total daily energy requirement on its own [17].

3.3.2. Carbohydrates

The carbohydrate content of soft rice averages 15.36%, representing the primary energy contributor, alongside fat and protein [18]. The carbohydrate source used in this formulation was 120 g of white rice. A carbohydrate content of 15.36 g/100 g contributes approximately 9.9% to the RDA for infants aged 9–11 months, which is set at 155 g per day according to the 2019 Ministerial Regulation. This carbohydrate value indicates that soft rice has the potential to serve as an adequate energy source in a complementary feeding menu [19].

3.3.3. Protein

The average protein content of soft rice was 3.55% (3.55 g/100 g). This protein content is primarily derived from tempeh, a plant-based protein source known for its high digestibility due to the fermentation process. Protein plays a vital role in tissue growth, cell formation, and the developmental processes of infants, particularly during the rapid growth period of 6–24 months [20]. According to the Regulation of the Minister of Health of the Republic of Indonesia Number 28 of 2019, the daily protein requirement for infants aged 9–11 months is 15 grams. With a protein content of 3.55 g per 100 g, the tempeh and moringa leaf soft rice contributes approximately 23.6% toward the daily protein needs of infants in this age group. Adequate protein intake is crucial, as it provides the nine essential amino acids that support the growth phase. A deficiency in any of these amino acids can inhibit growth rates, as protein deficiency is a primary driver of stunting, characterized by slowed physical growth and delayed bone maturation [21].

3.3.4. Fat

The fat content is relatively low at 0.12 g/100 g, representing only about 0.34% of the RDA for fat (35 g/day). Consequently, this product needs to be combined with other fat sources in a toddler's daily menu to support energy requirements and brain development [19]. This low percentage indicates that soft rice serves as a base that must be supplemented with additional lipid sources in the complementary feeding (MP-ASI) menu to ensure energy adequacy and support overall infant development. Essential fats are necessary for brain development, skin, hair, and eye health, as well as providing protection against communicable and non-communicable diseases, promoting fat storage, maintaining body temperature, and protecting vital organs [15].

3.3.5. Moisture Content

Soft rice (*nasi tim*) has a high moisture content (79.94%) due to the steaming method (*tim*). This results in a soft texture that aligns with an infant's oral-motor capabilities, making it easy to swallow.

3.3.6. Ash Content

The ash content of 1.04% reflects the total mineral profile (including calcium, phosphorus, and iron) derived from the rice, tempeh, and moringa leaves. The ash value represents the total inorganic mineral residue present in the food material. These minerals originate from the raw ingredients and are not lost during combustion because minerals are non-volatile at high temperatures. Mineral content is vital to the nutritional value of food, as minerals, such as calcium, phosphorus, and iron, play critical roles in bodily functions, such as bone formation, oxygen transport, and enzymatic reactions [22].

3.3.7. Crude Fiber

A crude fiber content of 1.46 g/100 g contributes approximately 13.3% of the daily fiber requirement (11 g), and remains within safe limits for toddlers. Fiber aids digestive function and helps prevent constipation. Crude fiber is a component of dietary fiber, consisting primarily of insoluble fractions. Examples of water-insoluble fibers include cellulose and hemicellulose, which have the capacity to prevent constipation [23].

3.3.8. Iron (Fe)

The iron content (0.92 mg/100 g) constitutes approximately 8.4% of the daily iron requirement (11 mg). Although this aids in iron fulfillment, it must be supplemented by other food sources to prevent anemia [24]. This iron content is sourced from tempeh and moringa leaves, both of which are known plant-based iron sources. Iron is an essential microelement; if iron stores are sufficient, the requirement for red blood cell formation in the bone marrow is consistently met [25]. However, if iron stores diminish and dietary intake is lower than the required amount, an iron imbalance occurs within the body. Children are particularly at risk for iron deficiency because of increased demands

during growth phases. Inadequate iron intake during childhood leads to growth retardation, which, if sustained over a long period, can result in stunting [26].

4. CONCLUSION

Based on the research findings, tempeh and moringa leaf soft rice (nasi tim) serve as potential alternatives for complementary feeding (MP-ASI) to prevent stunting, as they contain essential nutrients, such as protein for tissue growth and iron for hemoglobin formation. Data analysis indicates that formulation F3 was the most preferred product by panelists, achieving the highest average scores in the organoleptic tests: 3.97 for taste, 3.50 for color, 3.80 for aroma, and 3.53 for texture. Laboratory analysis of this formulation revealed a nutritional profile consisting of 75.38 kcal/100 g of energy, 3.55% protein, 15.36% carbohydrates, and 0.92 mg/100 g of iron. The product's soft texture, with an average moisture content of 79.94%, is considered highly suitable for the oromotor capabilities of infants aged 9–24 months. Consequently, the utilization of local food sources—specifically tempeh and moringa leaves—is proven capable of producing a complementary food product that is highly acceptable and fulfills the macronutrient and micronutrient requirements necessary to support optimal child growth.

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