SENSORY ANALYSIS OF INSTANT COMPLEMENTARY FOOD WITH FERMENTED EGG FLOUR SUBSTITUTION AS A SOURCE OF PROTEIN AND SELENIUM IN STUNTING CHILDREN

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ABSTRACT

Childhood stunting is a health problem associated with chronic malnutrition, particularly inadequate protein and selenium intake. Fermented egg flour was chosen because the fermentation process can increase the bioavailability of protein and selenium. This study aimed to develop and evaluate the sensory quality of instant complementary food formulated with fermented egg flour as a source of protein and selenium. The nutritional composition of this formulation has been reported in a previous study; therefore, this research specifically focuses on its sensory evaluation. The sensory test was conducted using a 9-scale hedonic method on the parameters of taste, aroma, texture, and color involving 66 semi-trained panelists (nutrition students). The research method used a completely randomized design (CRD) with four formulations: F0 (control) and F1, F2, and F3 as treatments with 10, 15 and 20% fermented eggs, respectively. Data analysis used one-way ANOVA and Kruskal-Wallis tests ($p<0.05$). The test results showed that the substitution of fermented egg flour had a significant effect on panelists' preferences in the aspects of color, taste, and aroma but not significant in texture; the protein content from 20.56% to 20.59%, 21.68%, and 22.54%, along with an increase in energy content from 417 kcal to 419 kcal, 427 kcal, 431 kcal in instant complementary food. However, higher fermented egg flour proportions reduced acceptance due to a fishy aroma. F1 (10% fermented egg flour) had the highest sensory acceptance, though its nutritional improvement was minimal, to optimize F3's nutritional benefits while improving sensory appeal, flavor enhancement within regulatory limits is recommended to better support children's nutrition.

Keywords: *Complementary Food (MP-ASI), Fermented Egg Flour, Organoleptic Parameters, Stunting*

INTRODUCTION

Stunting is one of the biggest nutritional problems affecting children in developing countries, including Indonesia. This condition occurs due to long-term malnutrition and has a significant impact on children's physical growth and cognitive development (Khairani, 2020). Based on WHO data in 2020, the global prevalence of stunting reached 22% of the toddler population or around 149.2 million children (UNICEF and WHO, 2021), In Indonesia, based on the 2018 Riskesdas survey, the prevalence of stunting was 30.8% (Depkes RI, 2018), decreased to 21.6% according to SSGI 2022 (Kemenkes RI, 2022), and 21,5% according to SKI 2023 (Kemenkes RI 2023). However, this prevalence still places Indonesia as the country with the fourth highest stunting rate in the world (WHO, 2023) . Stunting not only affects height but also increases the risk of degenerative diseases in adulthood, such as obesity, hypertension, and diabetes (Kemenkes RI, 2022).

Prevention of stunting must start early by providing adequate nutrition during the golden period of child growth, namely the age of 6 months to 2 years. At this age, children need additional nutritional intake that is not sufficient from breast milk alone, so complementary foods are needed (Dita and Herminiati, 2021). Nutrient-rich complementary foods ensure

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adequate infant nutrition and support optimal growth and development. However, many instant complementary foods on the market are often cereal-based, which may not meet the needs of protein and other important micronutrients. Therefore, children need alternative, complementary foods based on local nutrient-rich ingredients.

Previous studies have explored the benefits of local food ingredients as components of complementary foods, including eggs, which are known to have high-quality protein and important micronutrients such as vitamins A, E, and selenium (Muhammad et al., 2021).

However, fresh eggs have a short shelf life due to their high water content, making them more susceptible to microbial contamination. To overcome this problem, fermentation and drying into flour can extend the shelf life of eggs while increasing their nutritional content. Fresh eggs are highly perishable and prone to contamination by pathogens such as *Salmonella spp.* and *Escherichia coli* if not handled properly (Gantois et al., 2009). In contrast, fermentation has been shown to reduce microbial risks by lowering pH and producing antimicrobial compounds, such as organic acids and bacteriocins, which inhibit spoilage and pathogenic bacteria (Tamang et al., 2016). Additionally, the drying process further reduces moisture content, limiting microbial growth and extending shelf life (Song et al., 2021).

Fermentation of eggs with Saccharomyces cerevisiae yeast, contained in fermion, has been shown in several studies to break down proteins and fats into amino acids and free fatty acids, as well as increasing the bioavailability of selenium and other nutrients. Studies have shown that fermentation using *Saccharomyces cerevisiae* can increase selenium bioavailability by up to 50% by enhancing its solubility and conversion into more absorbable organic forms, such as selenomethionine (Sharma, 2020; Wulandari, 2022).

Protein and selenium are essential to help meet the intake of stunted children. This is because stunted children require optimal protein intake (Yanti at al., 2020). High protein sufficiency can reduce the risk of stunting by increasing amino acid levels that help release hormones for bone growth (Luqu et al., 2015).

Complementary food with high-quality and easily digestible protein is very important to support infant growth, where the combination of animal and vegetable protein complements the amino acids needed. In addition, protein adequacy is also significantly related to serum selenium levels because selenium requires protein to function effectively and is distributed throughout the body (Kadita et al., 2016).

Selenium primarily interacts with proteins by forming selenoproteins, a group of essential enzymes that play a critical role in antioxidant defense, thyroid hormone metabolism, and immune function. Selenocysteine, the biologically active form of selenium, is incorporated into these selenoproteins, which include glutathione peroxidases and thioredoxin reductases, both of which help protect cells from oxidative stress and maintain redox homeostasis (Rayman 2012). Therefore, inadequate protein intake can limit the synthesis of selenoproteins, reducing the biological effectiveness of selenium.

The protein and selenium content in instant MP-ASI with fermented egg flour can be a potential alternative to reduce stunting rates. Research in Malawi showed that giving eggs daily to children for six months increased energy intake and contributed to dietary diversity without reducing consumption of other staple foods ($p<0.05$) (Lutter et al., 2021).

In this study, skimmed milk in the complementary food (MP-ASI) formulation was replaced with fermented egg powder. This substitution was made considering that egg fermentation can enhance the bioavailability of protein and selenium compared to skimmed milk (Sharma, 2020). Additionally, several studies have shown that fermentation improves protein digestibility, making it easier to be absorbed by children at risk of stunting (Wulandari, 2022).

While skimmed milk is a good source of protein, fermented egg powder offers additional benefits in terms of essential amino acid content and micronutrients that are more optimal for supporting children's growth (Muhammad et al., 2021). Therefore, the substitution of skimmed milk with fermented egg powder in this MP-ASI formulation is the main focus of this research

to evaluate its nutritional benefits for growing children.

In addition to the nutritional content aspect, consumer acceptance or preference for MP-ASI products is also important to consider. Sensory attributes such as taste, aroma, texture, and color play a role in determining children's and parents' acceptance of the product.

Fermented egg flour is expected to provide optimal nutritional benefits and potentially enhance sensory characteristics, as suggested by previous studies. Research has shown that fermentation can reduce undesirable odors and improve umami taste due to the breakdown of proteins into amino acids and peptides, which contribute to flavor enhancement (Lee et al., 2020; Wulandari, 2022). Sensory evaluations from similar studies have also indicated that fermented egg-based products tend to have a more acceptable taste profile compared to their unfermented counterparts (Sharma and Kumar, 2020). However, further studies are needed to confirm these findings in the current formulation.

Sensory testing with the hedonic method is beneficial for measuring consumer preferences for the instant MP-ASI developed to ensure that babies like this product and it meets their nutritional needs. Thus, this study examines the sensory characteristics of instant MP-ASI made from fermented egg flour. This research addresses the gap in existing knowledge regarding the impact of fermented egg flour on the sensory acceptability of complementary feeding products, which has been limited in prior studies. While previous research has explored the nutritional benefits of egg fermentation (Lee et al., 2020; Wulandari, 2022), there is still a lack of studies evaluating how this process influences consumer acceptance in MP-ASI formulations. The results of this study are expected to contribute to the development of local MP-ASI products that are rich in nutrients, practical, and accepted by consumers as an effort to enhance the effectiveness of locally sourced MP-ASI in combating stunting in Indonesia.

EXPERIMENTAL DETAILS

Method

This study used an experimental design with a completely randomized design (CRD) to test the effect of adding fermented egg flour on the sensory of instant MP-ASI. This study involved four formulations, namely F0 (0% fermented egg flour as a control), F1 (10% fermented egg flour), F2 (15%), and F3 (20%). This formulation consists of ingredients such as fermented egg flour, brown rice flour, green bean flour, skimmed milk flour, sugar, and coconut oil, with the composition according to Table 1 below:

Table 1. Formulation of Instant MP-ASI with Fermented Egg Flour Substitution (%)

Material	Formulation			
	F0	F1	F2	F3
Brown rice	30	30	30	30
Green Bean Flour	28	28	28	28
Skimmed Milk Flour	20	20	15	10
Fermented Egg Flour	10*	10	15	20
Sugar	5	5	5	5
Coconut oil	7	7	7	7
Total	100	100	100	100

Description: *Formulation F0 uses unfermented egg flour

Making Fermented Egg Flour

The following is the process of making fermented egg flour (Figure 1). Making fermented egg flour eggs uses chicken eggs that are 1-3 days old, which are obtained directly from partner suppliers in the Animal Science Study Program at Diponegoro University to ensure their freshness and age within this range.

The use of fresh eggs, aged 1-3 days, in the production of fermented egg powder is crucial to ensuring the final product's quality. Fresh eggs have optimal internal qualities, such as egg white viscosity and yolk integrity, which can affect the fermentation process. Studies show that prolonged egg storage can lead to increased pH, decreased egg white viscosity, and structural changes in the yolk, all of which influence fermentation efficiency and final product quality (Ahmad, Yousaf and Khan 2018). Therefore, using fresh eggs is highly recommended to achieve optimal fermentation results.

Adjusting the pH to 5 by adding 10 grams of citric acid plays a crucial role in the production of egg flour. Lowering the pH to an acidic level enhances protein stability and prevents undesirable

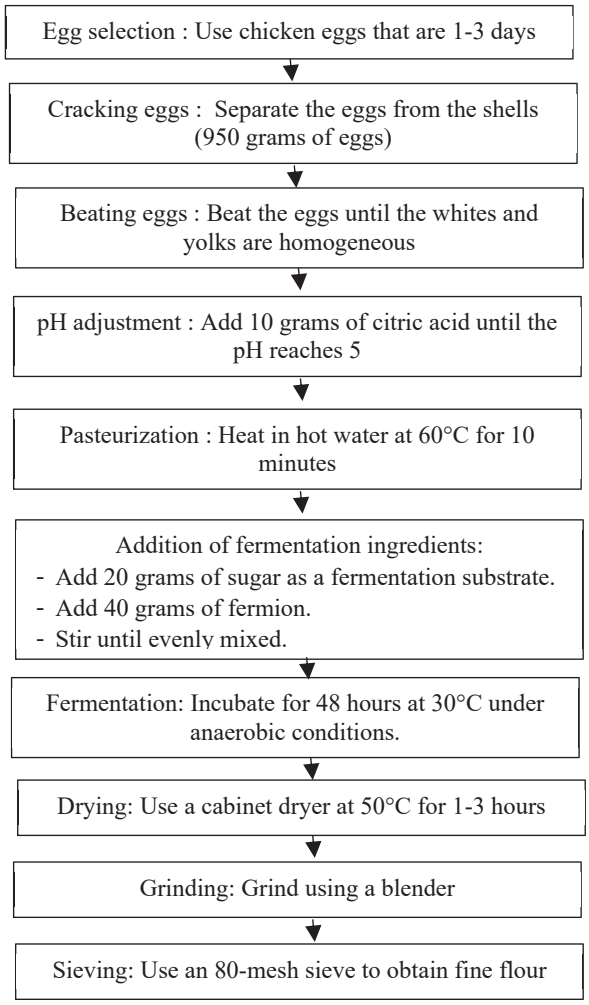

Figure 1. Flowchart of Making Fermented Egg Flour
Reference: (Fadhila et al., 2024)

denaturation, ensuring the retention of functional properties during processing (Sharma and Kumar 2020) Additionally, achieving an acidic pH inhibits the Maillard reaction, which occurs between reducing sugars and amino acids, thereby preventing unwanted browning and preserving the nutritional quality of the final product (Liu, Huang and Zhang 2019).

Acidification also improves the functional properties of egg proteins, such as foaming ability and water-binding capacity, which are essential for food applications (Wang, Zhao and Chen 2021). Therefore, adjusting the pH to an optimal acidic level is a critical step to maintaining the quality, color, and functionality of fermented egg flour. The egg formula is incubated using a stainless steel bowl covered with plastic wrap to maintain anaerobic conditions for 48 hours at 30°C, following standard anaerobic fermentation conditions.

Making Instant MP-ASI

Making instant powdered complementary food uses the dry mixing method (all ingredients are mixed in a dry state) and dried with a cabinet dryer. Raw materials not ready to serve, namely fermented egg flour, brown rice flour, green bean flour, and pandan leaves. Ready-to-serve ingredients include powdered sugar, skim milk, and palm oil. The following is the process of making instant MP-ASI:

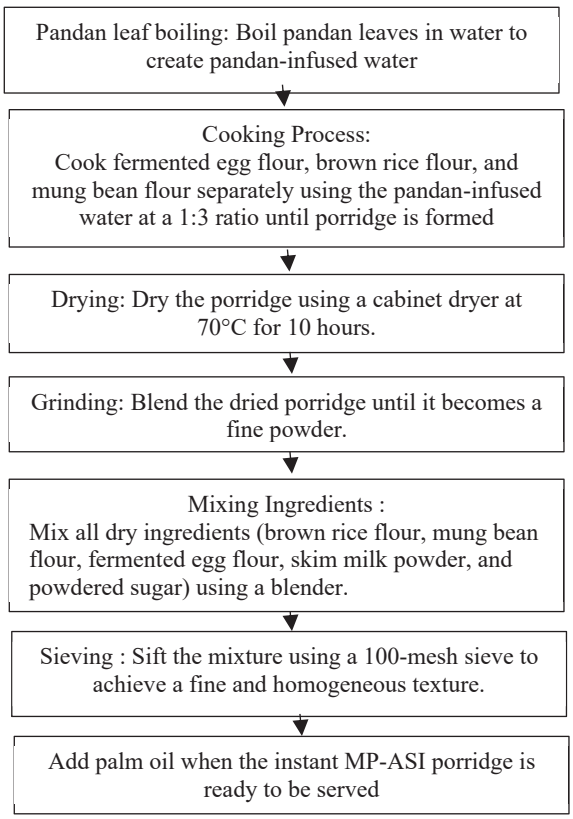

Figure 2. Flowchart of Making Instant MP-ASI

Research Sample

The research sample is an instant MP-ASI product made with fermented egg flour substitution, a total of four samples, and each formulation has met the energy, protein, and selenium content according to the SNI-2005 standard on the requirements for instant powdered MP-ASI. The nutritional content analysis of the product used for sensory testing was carried out

through proximate analysis at the SIG Laboratory (PT. Saraswanti Indo Genetech). MP-ASI products have nutritional content which can be seen in the table below:

Table 2. Nutritional content of instant MP-ASI/100g

Parameter	Formulation			
	F0	F1	F2	F3
Energy(kkal)	417	419	427	431
Protein (g)	20.56	20.59	21.68	22.54
Lemak (g)	11,60	11,73	13,12	14,29
Selenium (µg)	16.29	18.64	27.27	34.86

Reference : (Dewi et al. 2024)

Organoleptic Test

Testing using hedonic test uses human senses to see the quality of a product, including color, taste, aroma, and texture, using a 9-scale hedonic test (Rahman et al. 2020) and 66 panelists of Diponegoro University nutrition students; panelist calculations were obtained using the RSML (Required Sample Size for Minimum Level) metric.

All panelists have met the inclusion and exclusion criteria, namely being willing to be panelists, liking porridge products, not being allergic to the composition of the product to be tested, being sensitive to the five senses, having received hedonic test material, and not being sick. Panelists are faced with four instant MP-ASI products coded on each product with three numbers. In the organoleptic test, the samples presented to the panelists were in the form of instant MP-ASI porridge. Each of the four MP-ASI formulations was prepared by weighing 10 grams of instant MP-ASI powder per formulation, then adding 30 mL of warm water (55°C) and stirring until homogeneous. After that, 0.7 grams of palm oil was added, and the porridge was mixed again until evenly blended. Panelists can provide an assessment from the hedonic, and when they taste another product, the panelists must neutralize it by drinking water.

This study has obtained permission from the Health Research Ethics Commission of the Faculty of Medicine, Diponegoro University, with approval number No.440/EC/KEPK/FK-UNDIP/ VIII/2024, and was carried out by applicable research ethics standards, including written consent from the panelists.

Data Analysis

All data were first tested for normality before analysis. The research data were analyzed using the One Way ANOVA statistical test on taste, color, aroma, and overall parameters. In contrast, the texture used the Kruskal-Wallis test with a significance level of $p < 0.05$ to determine the difference in significance between groups using the LSD (Least Significant Difference) follow-up test. The Kruskal-Wallis test was chosen instead of ANOVA because the normality test showed that the texture data were not normally distributed, making a non-parametric approach more appropriate.

RESULT AND DISCUSSION

Providing appropriate complementary feeding is an important foundation for improving the growth and development of healthier children

Table 3. Hedonic Test of Instant MP-ASI Formulation

Parameter	Formulation				*p**
	F0	F1	F2	F3	
Taste	5.78±1.44^{a}	6.44±1.20^{b}	6.01±1.08^{ab}	5.09±1.49^{c}	0.000
Color	6.53±1.24^{a}	6.85±0.85^{a}	6.30±1.16^{ac}	6.13±1.14^{bc}	0.002
Aroma	5.53±1.46^{a}	6.33±1.11^{b}	5.14±1.35^{a}	4.60±1.46^{c}	0.000
Texture	6.23±0.93^{a}	6.67±1.32^{b}	6.33±0.85^{abc}	6.29±1.02^{ac}	0.082**
Overall	6.07±1.09^{a}	6.47±1.21^{a}	5.48±1.27^{bc}	5.21±1.17^{bc}	0.000

Description: Values presented are mean and SD
*One Way ANOVA indicates a significant difference ($p<0.05$)
**Kruskal-Wallis indicates no significant difference ($p>0.05$)
Different letters (a, b, and c) in one row indicate significant differences between formulations ($p<0.05$) based on one-way ANOVA and Kruskal-Wallis tests, followed by the LSD test.

and can significantly reduce stunting. The WHO recommends that complementary feeding be carried out promptly and adequately, namely by providing sufficient energy, protein, and micronutrients to meet the nutritional needs of growing children (Babys; et al., 2022).

The following is a discussion of the results of the formulation of instant MP-ASI products that are substituted with fermented egg flour:

The organoleptic test results showed significant differences in taste, aroma, and color parameters. Formulation F1 with 10% fermented egg flour obtained the highest score for taste (6.44±1.20) and aroma (6.33±1.11), formulation F3 with 20% fermented egg flour obtained the lowest score for taste (5.09±1.49), which indicated that the panelists did not prefer higher concentrations of fermented egg flour.

The results of the hedonic test showed panelist preferences for various sensory aspects of the instant MP-ASI formulation, namely taste, color, aroma, texture, and overall. The following is an explanation of each aspect:

Taste

Food tastes are produced by the stimulation of various senses in the human body, especially the senses of sight, smell, and taste (Fitriani and Kusumawaty, 2011). The taste aspect is a very important factor in the panelist assessment. Formulation F1 got the highest score for taste, which is 6.44 ± 1.20, which means that the panelists quite like the taste of the product; this also shows that the addition of 10% fermented egg flour provides an umami taste that is liked by the panelists without causing a fishy taste.

Previous studies have shown that fermentation can reduce the fishy aroma in egg-based products by breaking down sulfur-containing compounds and enhancing umami through the production of free amino acids (Wang et al., 2021). Additionally, fermentation has been reported to cause slight changes in color, resulting in a lighter or slightly brownish hue due to Maillard reactions and pigment modifications during the process (Zhao et al., 2019); on the other hand, F3 with 20% fermented egg flour got the lowest score in the taste aspect, which is 5.09 ± 1.49 (neutral taste).

The decrease in scores in formulations F2 and F3 was caused by the higher concentration of fermented egg flour, which caused a fishy or unpleasant taste in some panelists; this is likely influenced by the processing method, particularly the drying temperature of the fermented egg flour, which can intensify the release of volatile compounds contributing to off-flavors (Zhao et al., 2019). Additionally, the interaction between fermented egg flour and other ingredients, such as skimmed milk and mung bean flour, may affect the final taste perception. The presence of certain amino acids and sulfur compounds in fermented egg flour can also lead to a stronger umami or even slightly sulfurous taste, which may not be well accepted at higher concentrations (Kim, Lee and Park 2020).

Furthermore, the oil added during reconstitution of the instant MP-ASI may influence the overall flavor balance by affecting the dispersion of fat-soluble compounds (Li, Zhang and Xu 2021). This is because the assessment of the taste of a food can be influenced by several components, such as aroma, spices, texture, level of maturity, and temperature of the food (Utami, 2008).

Color

The color of food influences consumer taste and acceptance and reflects the quality of the processing process through its uniformity and brightness. Product color also has a significant effect on preference. F1 has the highest color score, which is 6.85 ± 0.85 (like very much), which shows a bright and attractive color without any striking changes; this can be influenced by adding the most significant amount of skimmed milk flour compared to other formulations.

Formulation F3, with 20% fermented egg flour and the least skimmed milk compared to other formulations, has the lowest color score of 6.13 ± 1.14 (like). The darker color intensity can cause this decrease due to the high content of fermented egg flour and low skimmed milk, which may be less attractive to some panelists. Fermented egg flour has a yellowish-brown color, while skimmed milk is white. The higher percentage of fermented egg flour in formula F3 contributes to a more intense brown color compared to formulations F0-F2.

This color change may also be influenced by the Maillard reaction between proteins and sugars during processing, further intensifying the darker appearance. Besides, the color of all formulations is almost the same, namely light brown. The brown color of this product is caused by the content of red rice flour and green beans that have undergone a cooking and drying process, resulting in a browning reaction.

This browning reaction occurs non-enzymatically. Namely, carbohydrates (consisting of simple sugars) react with amino acids when heated (Liang, et al., 2018) This is also supported by the high protein content which can affect the brownish color; the common thermal effects are non-enzymatic browning and protein denaturation. Protein denaturation is a decrease in the dispersibility/solubility of powdered food ingredients caused by drying at high temperatures in a short time, but in this study using a temperature of 70 ºC for 10 hours by previous research in the drying process of MP-ASI ingredients that are not ready to serve, namely a temperature of 70 ºC (Putri et al., 2019)**.** This drying temperature may influence the color of the final product due to Maillard reactions or pigment degradation. According to (Rahman et al., 2020), drying at moderate temperatures (60–80°C) can help retain the natural color of food ingredients by minimizing excessive browning reactions. In this study, the sensory assessment showed that the color of the MP-ASI product was still acceptable to the panelists, indicating that the use of 70°C was beneficial in maintaining color quality.

Aroma

The aroma of food enhances the taste and allows deliciousness to be recognized from a distance. The sense of smell assesses various odors that affect the product's appeal (Wahyuni, 2023). Aroma is another significant factor in the panelists' assessment of taste value. F1 got the highest aroma score with a value of 6.33 ± 1.11 (somewhat like), indicating that the aroma of fermented egg flour at a concentration of 10% gave a light aroma without an excessive fishy smell.

In the F3 formulation, which had 20% fermented egg flour, the aroma score decreased to 4.60 ± 1.46 (rather dislike); this score was lower because the fishy aroma became more pronounced. The fishy aroma in egg-based products is primarily caused by volatile sulfur compounds, such as hydrogen sulfide and trimethylamine, which are naturally present in eggs. The fermentation process may not completely eliminate these compounds, and at higher concentrations, they can become more noticeable, leading to lower acceptability scores (Wang et al. 2021), and which was caused by volatile compounds produced from food ingredients due to evaporation during the drying process (Wongpornchai, 2004).

The ingredients that go through the drying process in this MP-ASI formulation are green bean flour, red rice flour, and fermented egg flour, resulting in an aroma that is less preferred by the panelists.

In this study, boiled pandan leaves were added, and water was used to make green bean porridge and red rice porridge. The use of pandan here is permitted in the SNI requirements for Instant MP-ASI, which comes from natural ingredient extracts (e.g. vanilla extract, pandan) sufficient for a good production process (SNI,2005). Pandan leaves are commonly used as a natural food fragrance because of the aroma they produce (Zuyyin and Millatina, 2013).

Additionally, powdered milk was incorporated into the formulation, which may contribute to a more balanced aroma due to its lipid and protein content. According to Smith and Simpson (2021), dairy ingredients, particularly skimmed milk powder, can release lactones, ketones, and aldehydes, enhancing the creamy and slightly sweet aroma of food products. Furthermore, interactions between dairy proteins and sulfur-containing compounds from fermented egg flour may reduce undesirable odors, improving the overall sensory acceptance (Lee at al., 2020)

Texture

Food texture includes the structure, tenderness, and hardness felt in the mouth, affecting the appearance and appeal of the dish (Masturoh, 2018). The panelists also assessed the texture of the product; the texture of all formulations did not experience significant differences, as indicated by the results of the Kruskal-Wallis test analysis, namely *p 0.082 (p*

<0.05); this indicates that all formulations have almost the same texture.

F1 got the highest score for texture compared to other formulations, namely 6.67 ± 1.32 (rather like or tending toward like), F2 and F3 got slightly lower texture scores compared to F0, respectively 6.33 ± 0.85 (somewhat like) and 6.29 ± 1.02 (somewhat like), although the difference was not significant. This indicates that increasing the content of fermented egg flour does not significantly affect the texture, and changes in product characteristics result from the modification of starch and protein at high temperatures (Dalamin and Solomon, 2016).

Ideally, MP-ASI has a consistency like a yoghurt in a container and is dense in energy and nutrients; Walker proposed that the texture of porridge is a significant factor in energy-protein malnutrition (Amagloh, 2022)protein, and total aflatoxins contents in orange-fleshed sweetpotato (OFSP. F1 has a preferred texture due to the higher content of skimmed milk, which plays a role in forming a thick texture.

Protein in skimmed milk, primarily casein, is known for its water-binding ability, which contributes to a thicker consistency (Fox and McSweeney, 2015). In contrast, fermented egg powder contains albumin and globulin as dominant proteins, which differ in their water-binding properties and gel-forming capacity (Mine 2008). The texture of F3, which was less preferred by the panelists, may be attributed to the reduced skimmed milk content and the addition of fermented egg powder. The decrease in viscosity in F3 is likely due to the differences in protein composition, as casein in skimmed milk provides better water retention compared to the albumin in fermented egg powder (Wang, 2021).

Fermentation can break down proteins into smaller peptides, which reduces water binding capacity and produces a more liquid texture. In addition, the higher fat content in F3 also reduces the texture because fat makes the mixture thinner. All formulations in MP-ASI showed that the texture was still acceptable to panelists.

Overall

The overall assessment of all sensory aspects showed that F1 was the most preferred formulation overall, with a score of 6.47 ± 1.21 (somewhat like). F1 provides an optimal balance between taste, color, aroma, and texture, so panelists gave this formulation the highest score. In contrast, F3 obtained a lower overall score, which was 5.21 ± 1.17 (neutral), mainly due to the presence of a fishy aroma and taste that was less preferred by the panelists.

The results of the hedonic test showed that F1 was the most optimal instant MP-ASI formulation in terms of panelist acceptance because it provided a good balance of taste, color, aroma, and texture without causing an undesirable aroma or taste. Adding 10% fermented egg flour to F1 produced a more pungent umami taste without causing an excessive fishy aroma. Fermented egg flour at this concentration provided an optimal balance between taste and aroma; in contrast, F3, with 20% fermented egg flour, obtained the lowest score for taste and aroma. This decrease was due to the high content of fermented egg flour, which caused a more pungent fishy aroma and was not preferred by the panelists, but F3 had the highest nutritional content. Excessive fermentation can increase the production of specific volatile compounds, such as sulfur, responsible for the fishy aroma.

To maintain F3 with high nutritional content, as an alternative to preventing stunting, flavoring can be added to improve the aroma so that it will also affect the taste; the flavoring can be in the form of vanillin, which does not add or change the nutritional content, but can improve the aroma of instant MP-ASI with the standards permitted for instant MP-ASI. that is, no more than 7 milligrams per hundred grams of the ready-to-eat product (SNI, 2005).

In terms of nutritional content, MP-ASI products in this study can be an alternative that meets the needs of toddlers; providing MP-ASI optimally is an important foundation in efforts to improve the growth and development of healthier children and can significantly reduce stunting. The WHO recommends that complementary foods for breast milk be provided promptly and adequately, namely providing sufficient energy, protein, and micronutrients to meet the nutritional needs of growing children (Sukmawati et al., 2019).

MP-ASI in this study also fulfilled macronutrients, namely animal protein sources

from eggs and skimmed milk, vegetable protein from green bean flour, carbohydrates from brown rice flour and granulated sugar, and fat from coconut oil; this is by the theory that food consumption comes from at least four food groups; children tend to consume at least one animal food source, one fruit or vegetable at day, in addition to staple foods (grains, roots or tubers) (Babys; et al., 2022).

This MP-ASI with a balanced nutritional composition can contribute to fulfilling the nutritional intake of stunted children. This formulation is designed to meet selenium requirements as recommended by the Indonesian National Standard (SNI) for complementary foods, ensuring sufficient protein, energy, and essential micronutrients to support optimal growth and development. The inclusion of fermented egg flour and skimmed milk enhances protein quality and digestibility, while red rice and mung bean flour contribute to energy density and micronutrient diversity, including iron and zinc, which are crucial for child nutrition (SNI 01-7111.1-2005).

However, while improved complementary feeding plays a role in stunting prevention, it is important to acknowledge that stunting is a multifactorial issue influenced by infection, sanitation, maternal nutrition, and overall dietary diversity (Black, 2013). Thus, this product is expected to support optimal nutritional intake as part of a broader strategy to address stunting, rather than being a standalone solution.

CONCLUSION

The addition of fermented egg flour to instant MP-ASI increased its nutritional content, particularly protein and selenium, with the F3 formulation having the highest levels. The F3 formulation contains 22.54 g of protein and 34.86 µg of selenium per 100 g of product, significantly contributing to protein and selenium intake. However, the sensory acceptance of F3, particularly in terms of taste and aroma, tended to be lower due to a stronger fishy aroma.

In contrast, the F1 formulation provided an optimal balance between nutritional adequacy and organoleptic acceptance in terms of taste, aroma, color, and texture, making it the most preferred formulation overall. The preference for F1 may be attributed to its moderate level of fermented egg flour, which enhances the umami taste while minimizing undesirable off-flavors. Further modifications, such as adding natural flavoring agents (e.g., lemon extract or pandan leaves) or SNI-approved flavorings (such as vanilla), could improve the sensory acceptance of F3 without compromising its superior nutritional value.

The findings of this study suggest that F1 has the potential to be a recommended complementary food formulation due to its balanced nutritional composition and favorable sensory properties. However, further research, including large-scale consumer acceptance testing and long-term studies, is needed to validate its effectiveness and feasibility for widespread implementation in complementary feeding programs.

RESEARCH LIMITATIONS

The organoleptic test conducted by semi-trained panelists is still in the preliminary stage. For that, it is necessary to have panelists from consumers, such as mothers of toddlers, to re-ensure the assessment is in accordance with the target. Furthermore, to improve the aroma, it is necessary to add flavors permitted by SNI, such as vanilla flavors.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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