
RESEARCH ARTICLE

Innovation of Moringa Leaf and Eel Noodle as Functional Food Diversification for Stunting Prevention

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ABSTRACT

The problem of stunting is still a scourge for future generations of the Indonesian nation. Local foods that have good nutritional content are Moringa leaves and eel. In this condition, moringa and eel leaf combination noodle formulation innovation is needed as a functional food. The study's objectives were 1) to determine the subject's acceptance of the moringa and eel leaf noodle innovation and 2) to determine whether there is an effect of giving moringa and eel leaf noodle innovation with stunting prevention. This type of research is quasi-experimental with a One-group pre-test and post-test design. This research was conducted in Parepare City and Sidenreng Rappang district in July - August 2024. The test sample selected was 34 people, with details of 17 people in the treatment group and 17 in the control group. Data analysis to determine acceptability was an organoleptic test, while to determine the relationship between the provision of moringa and eel leaf noodle innovation with stunting prevention was using quasi-experimental through Paired sample t-test mean difference between pre-test and post-test with a significant level of 95% ($\alpha = 0.05$). The results showed that the average assessment of mothers of toddlers towards noodles containing moringa and eel leaves, especially in the indicators of color and texture, reached the criteria of liking, while aroma and taste obtained criteria quite like. The average body weight of toddlers before giving the noodles was 9.74 kg, and after giving, the average body weight of toddlers increased by 0.51 kg to 10.25 kg. The statistical analysis results showed a p-value = 0.002, which is smaller than the significance level α (0.05), implying a significant effect of the provision of moringa and eel leaf noodle innovation on stunting prevention. The study concludes that moringa and eel leaf noodle formulations affect stunting prevention.

KEYWORDS

Innovation, Noodle, Moringa leaf, Eel, Stunting

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1. Introduction

The problem of stunting is still a scourge for the future generations of the Indonesian nation (Essa WY, Nurfindarti E, Ruhyana NF, 2021) (Atamou L, Rahmadiyah DC, Hassan H, Setiawan A, 2023). Stunting has the highest prevalence compared to other nutritional problems (Khaliq A, Wraith D, Nambiar S, Miller Y, 2022). The prevalence of stunting among Indonesian toddlers is 36.4% (Ayuningtyas D, et al, 2022). South Sulawesi is among the three provinces with the highest stunting prevalence rate, which is 35.7% (Riyadh NA, Batara AS, Magister AN, 2023). One of the factors causing stunting in toddlers is unbalanced food intake (Feng J, Gong Z, Wang Y, Huo J, Zhuo Q, 2022) (Alzoubi KM, et al, 2021). Stunting is caused by problems with nutritional intake consumed during pregnancy and toddlerhood (Beluska-Turkan K, et al, 2019).

Interventions that have been carried out to prevent stunting are Supplementary Feeding for pregnant women and toddlers (Soofi SB, et al, 2021) (Sufri S, et al, 2023). Food is a source of energy, protein, vitamins and minerals (Fetriyuna F, et al, 2021). The type

of food used in making supplementary food is chosen from local food (Perito MA, Coderoni S, Russo C, 2020) (Affonfere M, et al, 2021). Local food ingredients are very important to develop because they have prospects as functional foods and can support sustainable food security (Arwanto V, et al, 2022).

Local foods that have good nutrient content are Moringa leaves (*Moringa oleifera*) (Basri H, Hadju V, Zulkifli A, Syam A, Indriasari R, 2021). Moringa leaves are a food that is easy to find and rich in macro and micro nutrients (Usman, Fitriani U RT, 2022) (Hodas F, Zorzenon MRT, Milani PG, 2021). The content favoured in Moringa is protein, vitamin A, and iron (Teye E, Deha CI, Dadzie R, Macarthur RL, 2020). Another benefit of Moringa leaves is that it can improve nutritional status in malnourished children (Agedew E, et al, 2022). Besides Moringa leaves, eels also have high nutritional content (Rika Resmana DP, 2020). Eel (*Monepterus albus*) is one type of fish that has a delicious taste (Herawati VE et al, 2018). Eel has a high protein content and is rich in amino acids that play an important role for growth and muscle building (Rika Resmana DP, 2020). Every 100 grams of eel has a content of 303 Cal; 27 fat; with omega-3 saturated fatty acid content ranging from 4.48 grams - 11.80 grams; 18.4 grams of protein (Zumria, Laenggeng AH, 2019).

The problem is that, despite being rich in macro and micronutrients, not many people know the content of Moringa leaves so that its utilisation is still very low. Likewise with eel, although it is rich in nutrients, eel consumption by the community is low due to its snake-like shape. Therefore, it is necessary to diversify products or functional foods to increase public consumption of local foods (Imelda I, Kusriani N, Hidayat R, 2017) such as by making noodles (Aulia SR, Heriyadi SA, Maharani D, 2019). Noodles are distributed throughout the world and are a product that represents a distinctive taste and is convenient for consumption by the public (Sae-Eaw A et al, 2022). The results of the study (Usman, Sulaeman, Z. Suherman. Umar, F. 2023) found that the amount of nutritional content of noodles (Energy, Protein, Fat and Iron) can meet daily needs and the subject's acceptance of moringa and eel noodles, especially colour and texture indicators get the criteria like.

Some studies report the nutritional content of Moringa leaves such as a study with the title *Is instant porridge with a high calcium content based on Moringa oleifera as an alternative baby food to prevent stunting in Indonesia?* The article was taken from the *Journal of Public Health Research* journal researched by Septa Katmawanti, Supriyadi, and Fariha Mariroh in 2019 in Indonesia which explains that fresh Moringa leaves contain vitamin A, vitamin C, Vitamin B6, calcium, potassium, iron, and protein, and have a high nutritional content, compared to other foods (Katmawanti S, Supriyadi, Mariroh F, 2021). The conclusion with the Borg and Gall method¹² is that moringa leaves have complete nutritional content including protein, vitamin C, calcium, and energy.

Research with the title *Eel Chips (*Monopterus albus*) Can Increase Haemoglobin Levels in Teenage Girl* published in the *Sapporo Medical Journal* by Rika Resmana and Dewi Purwaningsih reported on eel content. The conclusion is that the nutritional content of eel chips can increase haemoglobin levels in adolescent girls with an average increase of 1.429 mg%.

Research with the title *Sensory, Physicochemical, and Cooking Qualities of Instant Noodles Incorporated with Red Seaweed (*Eucheuma denticulatum*)* published in the *MDPI* journal was researched by Wee Yin Koh, Patricia Matanjun, Xiao Xian Lim and Rovina Kobun in 2022 in Switzerland explaining that noodles are not always healthy so it is necessary to produce noodles with additional wheat flour and potatoes with seaweed (Koh WY et al, 2022). The conclusion of the study is that the addition of seaweed powder to the noodles will weaken the tensile strength and soften the noodles so as to increase the attractiveness.

Further research reports the superiority of Moringa leaves as an ingredient in foods such as the study with the title *Potentiality of Moringa oleifera as a Nutritive Ingredient in Different Food Matrices*. The article was taken from the journal *Plant Foods for Human Nutrition* researched by Carla Trigo, María Luisa Castelló, and María Dolores Ortolá in 2022 in Spain explaining that the formulated food industry is growing rapidly and moringa is becoming an alternative food for food fortification (Trigo C, Castelló ML, Ortolá MD, 2023).

Under these conditions, innovation in the formulation of noodles with a combination of moringa leaves and eel is needed as a functional food for stunting prevention, and this is in line with the spirit of national research as stated in the National Research Master Plan 2017-2045 for Priority industries, especially the Food Industry such as formulation technology and production of special food / functional food. In addition, this research also has an impact on the potential use of local food in functional food products. The new thing that will be contributed by researchers is to diversify functional food in the form of noodle preparations with a combination of moringa and eel leaves to prevent stunting. The combination of moringa and eel leaves is a new innovation in creating healthier and more nutritious noodle products. Some of the novelty that can be presented by this innovation such as higher nutritional value, antioxidant effects, improved health, and environmentally friendly noodles.

Based on the description above, the objectives of the study are 1) to determine the subject's acceptance of the moringa and eel leaf noodle innovation and 2) to determine whether there is an effect of giving moringa and eel leaf noodle innovation with stunting prevention.

2. Methodology

This type of research is a Quasi experiment with a One-group pre-test and post-test design. This research was conducted in Parepare City and Sidenreng Rappang district in July - August 2024. The stages of this study began with the formulation of a combination of moringa and eel noodles at the Nutrition Laboratory of Muhammadiyah University of Parepare. Furthermore, determining the control group and treatment group and determining the health parameters to be measured, such as weight, height, and head circumference for toddlers, and measuring the nutritional status of both groups (pre-test). The next stage is to

give moringa and eel noodles to the treatment group and give regular food to the control group for a specified period of time (1 month) while monitoring the health development of both groups. After 1 (month) of treatment and monitoring the health development of the two groups, the nutritional status of the two groups was measured, both the control group and the treatment group (post-test). The test sample selected was 34 people, with details of 17 people in the treatment group and 17 people in the control group.

The data collection method to determine the quality or acceptability of noodles to the community was carried out by preparing a questionnaire to measure the community's acceptability or liking and determining the test sample.

Data analysis used to determine the subject's acceptability of noodle innovation is the organoleptic test. To measure the subject's liking for the noodle formulation with five scales, namely dislike (1), less like (2), quite like (3), like (4), and very like (5). The last step is to conduct a bivariate analysis to determine the nutritional status of toddlers before and after giving a combination of moringa and eel noodles. Data analysis to determine the relationship between the provision of innovative moringa and eel leaf noodles with stunting prevention is using quasi-experimental through the Paired sample t-test mean difference between pre-test and post-test with a significant level of 95% ($\alpha = 0.05$).

3. Results and Discussion

Subject characteristics

Table 1 describes the characteristics of the subjects according to the criteria of age, occupation, latest education, and child age.

Table 1. Subject characteristics based on age, latest education, mother's occupation, and age of toddler

Characteristics	Frequency (f)	Percentage (%)
Umur Ibu (Tahun)		
< 30	5	14,71
31- 40	19	55,88
41- 50	4	11,76
51- 60	4	11,76
< 60	2	5,89
Total	34	100,00
Mother's Last Education		
SMA	12	35,29
Strata Satu (S1)	16	47,06
Strata Dua (S2)	6	17,65
Total	34	100,00
Mother's Occupation		
HOUSEWIFE	9	26,47
Self-employed	4	11,76
Private Employee	15	44,12
ASN	6	17,65
Total	34	100,00
Child's Age (Month)		
\leq 36	6	16,67
37 – 48	9	26,67
\geq 49	19	56,66
Total	34	100,0

Table 1 displays data regarding the age distribution of the subjects, where the highest percentage of age is in the range of 31 - 40 years at 55.88% and the lowest in the age group under 60 years at 5.89%. Meanwhile, the subject's last education level shows the highest percentage at the Bachelor's degree level (S1) of 47.06% and the lowest at the Master's degree level (S2) of 17.65%. In terms of occupation, the highest percentage of subjects worked as Private Employees at 44.12%, while the lowest worked as Self-employed at 11.76%. For the age of the child, the highest percentage was at the age of over 49 months at 56.66%, while the lowest was at the age of under 36 months at 16.67%.

Composition and Nutritional Content of Moringa and Eel Combination Noodles

Moringa leaf combination noodles were made in 2 formulations with the composition as shown in Table 2.

Table 2. Composition of moringa and eel leaf combination noodles

No	Formula Ingredients	Weight	
		Formulation 1	Formulation 2 (gr)
1	Moringa Leaf Flour (gr)	10	10
2	Eel Flour (gr)	30	30
3	Wheat flour (gr)	160	190
4	Maizena (gr)	0	10
5	Egg (egg)	1	1
6	Oil (tbsp)	1	3
7	Salt (gr)	6	6

The results of laboratory tests showed the value of nutritional content (energy, protein, fat and iron) of moringa and eel leaf combination noodles as shown in Table 3.

Table 3. Nutritional content of moringa and eel leaf combination noodle formulation (per 100 grams)

No.	Content	Formulation 1	Formulation 2
1	Energy	140 kkal	169,38 kkal
2	Protein	9,26 %	8,77 %
3	Fat	0,44 %	0,70 %
4	Iron (fe)	35,21 µg/g	37,06 µg/g

The data in Table 3 shows that the total energy content of formula 2 of 169.38 kcal is higher than formula 1 of 140 kcal. The amount of calories is contributed by the use of wheat flour and cornstarch, which have higher proportions in formula 2 compared to formula 1. Energy is used to support daily activities. Based on the Nutrition Adequacy Rate 2019, it is known that the amount of energy needed by children aged 1-3 years is 1350 kcal. The calorie content of formula 2 noodles per 100 g can meet 12.54% of the calorie needs of children aged 1-3 years and 10.37% for formula 2. The amount of energy needed by each person is different depending on age, activity, physiological conditions, and other factors.

The total protein content of formula 1 was 9.26%, while formula 2 was 8.77%. The higher protein content of formula 1 was due to the higher proportion of eel flour to wheat flour in formula 1 than in formula 2. The protein content of the noodles was contributed from eel flour and eggs as well as partly from the use of high-protein wheat flour. Consumption of noodles per 100 grams of Formula 1 can fulfill 46.3% of the protein needs of children aged 1-3 years and 35.08% of children aged 4-6 years. The total protein requirement for children aged 1-3 years is 20 grams and 4-6 years is 25 grams (AKG, 2019). Protein is needed by children for growth and to prevent stunting.

Based on the fat content, the percentage of fat content in formula 1 was higher at 0.70%. This amount is higher because more oil is used in the making of formula 2 than formula 1. The fat content also comes from the use of eggs in making the noodles. The results of the iron content examination showed that the amount of iron content in formula 2 was higher at 37.06 µg/g, 1.85 µg/g different from formula 1 (35.21 µg/g). Iron is needed for child growth and to support the physiological needs of pregnant women. Iron can prevent iron deficiency anaemia in children and pregnant women. Iron in the body functions to form red blood cells which are made in the spinal cord and produce haemoglobin which plays a role in transporting oxygen to all parts of the body. Based on the AKG 2019, the amount of iron requirement for children aged 1-3 years is 7 mg and 10 mg for children aged 4-9 years. The iron content in the noodles comes from the use of moringa leaves, eggs and some eel flour.

Acceptability of moringa and eel leaf combination noodles

Analysis of the average subject's acceptability of moringa leaf formulations showed significant results on four indicators, namely colour, aroma, texture, and taste, which are presented in Table 4.

Table 4. Mean subject responses to noodle formulations containing moringa and eel leaves in terms of colour, aroma, texture and taste

Indicator	Moringa Leaf and Eel Combination Noodles	
	Average	Criteria
Colour	4,06	Like
Aroma	3,46	Quite Like
Texture	3,96	Like
Taste	3,47	Quite Like

The data contained in Table 4 shows that the average assessment of mothers of toddlers towards noodles containing moringa and eel leaves, especially in the indicators of colour and texture, reached the criteria of liking, while aroma and taste obtained the criteria of moderately liking. Acceptability is a mechanism used to test the acceptability of food products by involving the five senses (Hasyim and Hapzah, 2019). The concept of acceptability reflects an individual's response to liking or disliking a food product through organoleptic testing (Kurnia Sari et al., 2017). The hedonic test is important because it provides an overview of the subject's acceptability of food products by assessing the level of liking based on the criteria of colour, aroma, texture, and taste (Rustamaji and Ismawati, 2021).

Colour is one of the quality elements that influence the first impression that determines people's choices, so colour is considered an important organoleptic attribute in food products (Akaso et al., 2021). Colour is a major factor in choosing food products, because bright colours can increase people's interest in consuming food and increase appetite. The results showed that the colour of moringa and eel noodles was liked by the majority of the subjects, indicating that the colour of the moringa and eel combination noodle formulation was liked by the subjects. Some of the reasons subjects liked the colour of moringa and eel noodles were that the colour was natural and did not use coloring agents, making it safe for consumption. However, some subjects gave suggestions to use fresh moringa leaves to produce a bright noodle colour and look fresh to attract consumers. The results of this study are in line with research conducted by Hikmawati Mas'ud (2021) which states that the colour of food is mostly preferred by respondents (Mas'ud and Fitri, 2021). In several studies, colour was found to have an important role in improving the first impression and increasing people's liking for a food product (Iskandar et al., 2019).

Aroma has the ability to reflect the deliciousness of a food product. Food products tend to be more desirable to the public if they have a unique and attractive aroma (Rustamaji and Ismawati, 2021). The findings of the study showed that the majority of subjects moderately liked the aroma of moringa and eel noodles. This indicates that the aroma of moringa and eel noodles is quite favourable. The aroma of moringa and eel noodles only received a fairly favourable rating by the community due to the addition of eel which gives a distinctive aroma. The addition of moringa leaf extract in making wet noodles with mocaf flour substitution shows significant differences in terms of colour, aroma, and taste (Khasanah Via, 2019).

Texture is one of the visual elements that can be seen directly by consumers, so it has significant potential in influencing the assessment of a food product (Letlora et al., 2020). Food texture has an important role in determining public acceptance of a food product, because it can be one of the factors that influence public favourability (Iskandar et al., 2019). The results showed that the majority of subjects liked the texture of moringa and eel noodles. The texture of moringa and eel noodles was favoured by the subjects because it gave a soft impression and retained the original shape of the noodles, thus giving a more attractive and satisfying impression.

Flavour is the result of a combination of various food ingredients that can be assessed through human senses (Heluq and Mundiastuti, 2018). Findings from the study showed that the majority of subjects only rated the taste of moringa and eel noodles as moderately favourable. Although moringa leaves have a bitter taste due to the content of tannin compounds, the bitter taste can be overcome by adding other ingredients as needed, but the addition of eel has little effect on taste because many people are not accustomed to eel consumption. Baby porridge products with moringa leaf substitution based on organoleptic evaluation showed that flavour had a significant effect (Katmawanti et al., 2021).

The results of this study reinforce previous findings that food products using moringa leaves as a substitute ingredient can have high acceptance values, both in terms of colour, aroma, texture, and taste (Heluq and Mundiastuti, 2018). This study also strengthens the findings that new cake products with the addition of moringa flour can be a public favourite, both from the aspects of colour, aroma, texture, and taste (Hasyim and Hapzah, 2019). The results of the study provide confirmation that product formulations such as moringa noodles and eel, can be produced to become daily consumption for the community. Moringa has potential as a functional food and natural food additive (Fabiane Hodas). One of the advantages of eel fish wet noodles is its very high protein content compared to wet noodles in the market (Najmia, H., Mahreda, E. S., Mahyudin, R. P., & Kissinger, 2021).

The effect of giving moringa and eel noodle formulations on changes in body weight of toddlers as shown in Table 5.

Table 5. Effect of Noodle Formulation on Weight Gain of Toddlers

Treatment	n	Median	Body Weight Mean \pm SD	T	P-value
Sebelum	34	9,74 (8,9-11,4)	10,11 \pm 1,297	-3,216	0,002
Sesudah	34	10,25 (9,3-11,8)	10,82 \pm 1,499		

*Paired t-tes

Data from Table 5 shows that the body weight of toddlers before and after giving moringa and eel leaf noodles has changed. The average body weight of toddlers before giving the noodles was 9.74 kg, and after giving, the average body weight of toddlers increased by 0.51 kg to 10.25 kg. The results of statistical analysis showed a p value = 0.002, which is smaller than the significance level α (0.05), implying a significant effect of the provision of moringa and eel leaf noodle innovation on stunting prevention. Thus, it can be concluded that the noodle formulation plays a role in significantly increasing the body weight of toddlers.

Moringa plants, as a local food, are known to have rich and multipurpose nutritional content, and have potential as medicine (Suheti et al., 2020). Fresh Moringa leaves are proven to contain 0.7g of iron and 6.7g of protein per 100g. The content of protein, energy, fat, and iron in moringa leaves is very important for the formation of hemoglobin (Rusmataji, 2021).

The results of this study are supported by the results of previous research which informs that continuous provision of moringa leaf innovation will have an impact on increasing the body weight of toddlers (Muliawati, 2020). In addition, this research is also supported by previous research which informs that the eel produced has met the standards of additional food for toddlers, especially cases of malnutrition (Hikmah et al., 2021). Moringa leaves can be a good alternative to improve the quality and quantity of protein in food products (Ginoga et al., 2023).

Another study shows that moringa leaf flour has a positive impact on the prevention and management of nutritional problems for pregnant women and toddlers (Muliawati, 2020). Other findings indicate that giving moringa leaf flour to pregnant women affects the birth weight of babies (Kasrida & Patmahwati, 2020). Another study also highlights a significant difference in the average weight gain of toddlers, showing the impact of giving cookies with added moringa leaf flour to undernourished toddlers (Abdullah et al., 2022). Thus, the use of moringa leaf flour can be an effective strategy in improving nutritional status and health in various groups, especially toddlers, to prevent potential stunting in toddlers.

4. Conclusion

The research on the invention of noodles with moringa leaves and eel represents notable progress in combating stunting, a pressing public health concern in Indonesia. This research is consistent with the National Research Master Plan 2017-2045, highlighting the advancement of functional foods. The project seeks to augment nutritional intake by incorporating moringa and eel into noodle recipes, hence providing increased nutritional value and antioxidant characteristics. The research, conducted in Parepare City and Sidenreng Rappang area, employed a quasi-experimental design featuring a one-group pre-test and post-test methodology with 34 participants. The experimental group ingested the moringa and eel noodles, whereas the control group adhered to their standard diet. Health metrics, including weight, height, and head circumference, were evaluated to determine their influence on stunting prevention. The results indicated a notable enhancement in the nutritional status of toddlers consuming the novel noodles, with average body weight rising from 9.74 kg to 10.25 kg after one month, achieving a statistically significant p-value of 0.002. This suggests that the noodle formulation significantly aids in the prevention of stunting. Furthermore, organoleptic evaluations indicated favorable reactions concerning color, texture, scent, and flavor, with the noodles being generally well-regarded. The natural color and texture were valued, although the aroma and taste garnered middling evaluations, probably due to the distinctive flavor of eel. In summary, the combination of moringa and eel noodles presents potential as a functional food to address stunting, delivering vital nutrients and promoting local food use, thus enhancing sustainable food security and public health outcomes.

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Conflicts of Interest: Declare conflicts of interest or state "The authors declare no conflict of interest."

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