

## Physical and Chemical Analysis of Anchovy Nuggets with Additional Moringa and Cassava Leaves to Prevent Stunting

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### ABSTRACT

*Supplementation of moringa and cassava leaves in anchovy nuggets has can improve nutrition value. The aim of this study was to evaluate the effect of moringa and cassava leaves in enriching nutrition of anchovy nugget. The experiment was performed with five compositions (anchovy:moringa leaves:cassava leaves), namely F0 (100:0:0), F1 (96:2:2), F2 (92:4:4), F3 (88:6:6) and F4 (84:8:8). The physical parameters included color analysis and organoleptic test using 5 points hedonic test involved 25 panelist. Nutritional content was determined through proximate analysis. Results show that addition of moringa and cassava leaves decreased the color of anchovy nuggets, except the yellowness which was significantly increased in F3 treatment. The highest protein content was obtained from F4 formulation, the highest carbohydrate content was given by F3 and F4 treatments, and the lowest fat content was provided by nuggets from F3 and F4. The highest organoleptic score was F0 for taste, F2 and F3 for flavor, F3 for color, and F3 and F4 for overall scores. The supplementation of leaves generate unpleasant flavor. The addition of 6 g moringa and cassava leaves improve nutritional value of anchovy nuggets with acceptable sensory attributes that can be employed to solve stunting problem.*

## 1. INTRODUCTION

Stunting is a nutritional issue affecting children, potentially compromising their quality of life and hindering optimal growth and development (Pramahdyta *et al.*, 2023). This condition is measured based on the weight and height of children according to standards from the World Health Organization (WHO) (Santi *et al.*, 2021). The family plays a very important role in providing food with sufficient nutritional value. Data on the value of stunting families according to the National Family Planning Population Agency (BKKBN) in the second semester of 2023 amounted to 11.3 million families. Various prog are continuously implemented by the government to mitigate the stunting issue. The primary determinants of nutritional problems in children, such as stunting, include insufficient nutritional intake and suboptimal health status. Efforts to reduce stunting primarily target the underlying causes of nutritional issues, which encompass factors related to food security, environmental conditions, and social determinants (Widayani *et al.*, 2022). These include implementing healthy eating and childcare practices. Particularly through approaches that focused on nutritious food, access to health services for prevention, treatment, and environment al health, which includes the provision of clean water and sanitation facilities. The most of children prefer like umami, taste, and aroma of fish compared to vegetables (Prayitno & Rahim, 2021).

Therefore, there is a need for food innovation that contains animal and vegetable protein to meet the nutritional needs of children. Nuggets are one of the processed animal food products that are widely consumed (Asrar & Ristanti, 2023). Nuggets are an alternative solution in protein consumption and are most popular with children (Zaen *et al.*, 2020). Nuggets are processed with main ingredients such as fish meat, chicken, fish, and shrimp (Trigo *et al.*, 2023). Fish is a

high-protein animal food source, as it contains a variety of essential amino acids that are easily digestible by the body (Rahman *et al.*, 2020). One of the most dominant marine fish in Indonesia is anchovies (Canti *et al.*, 2024). Anchovies have a high protein content, the content in fresh anchovies is 16.32–22.20%, the content in dried anchovies is 60.20%–68.82%. Nugget diversification can be developed with the content of vegetable proteins. The content of moringa leaves had rich of antioxidants that are good for health (Rasak *et al.*, 2023). Moringa leaves can improve nutritional intake in children, aiding in weight and height growth, thereby helping to mitigate stunting (Cahyaningsih *et al.*, 2025). Moringa leaves have been proven to be biased against stunting (Sari, 2022). Cassava leaves have a protein content of 29.4–30.0% and mostly applied for animal feed (Amare *et al.*, 2024). In a previous study, FAO with the help of the World Bank raised cassava plants as the main program to overcome the malnutrition problem of 200 million people in the sub-Saharan region. The addition of cassava leaf flour increase the nutritional value of the catfish nuggets (Juniarsana & Agustini, 2023). It gives new idea for addition cassava leaves on anchovy nugget and impact of nutrition value.

The urgency of this study is that the value of stunting rates is still relatively high and there has been no evaluation of the nutritional value and physical properties of anchovy nuggets with cassava and moringa leaves substitution. This study has the main objective of identifying physical and chemical analysis trough organoleptic test, physical, and proximate analysis. The output of the research can show the nutrition value of addition moringa and cassava leaves effort to prevent stunting. The results of the chemical test on anchovy nuggets gave the best value in F4. It proven by the average value of organoleptic test, physical, and chemical analysis. This is proven that anchovy nuggets with cassava leaf and moringa leaf substitution have the right nutritional value in an effort to prevent stunting.

## 2. MATERIALS AND METHODS

### 2.1. Materials

The materials used in making anchovy nuggets included dried anchovies, moringa leaves, cassava leaves, wheat flour, cornstarch, sugar, pepper, salt, garlic, eggs, and water. All ingredients are obtained from the traditional market of Menganti District, East Java. The tools used in this study included knives, basins, spoons, blenders, meat blenders (choppers). This research was carried out in the Airlangga University Laboratory.

### 2.2. Methods

Five single treatments of adding moringa and cassava leaves included F0 (control, 0 g), F1 (2 g), F2 (4 g), F3 (6 g), and F4 (8 g). Moringa and cassava leaves were given in the form of dry leaf flour. Table 1 presented the detailed formulations.

Table 1. Anchovy nugget formulation with moringa and cassava leaf substitution

| Material         | F0       | F1       | F2       | F3       | F4       |
|------------------|----------|----------|----------|----------|----------|
| Anchovy meat (g) | 100      | 100      | 100      | 100      | 100      |
| Moringa leaves   | -        | 2 g      | 4 g      | 6 g      | 8 g      |
| Cassava leaves   | -        | 2 g      | 4 g      | 4 g      | 4 g      |
| Garlic           | 6 cloves | 6 cloves | 6 cloves | 6 cloves | 6 cloves |
| Pepper           | 5 g      | 5 g      | 5 g      | 5 g      | 5 g      |
| Chicken eggs     | 2 pieces | 2 pieces | 2 pieces | 2 pieces | 2 pieces |
| Cornstarch       | 30 g     | 30 g     | 30 g     | 30 g     | 30 g     |
| Flour            | 40 g     | 40 g     | 40 g     | 40 g     | 40 g     |
| Salt             | 10 g     | 10 g     | 10 g     | 10 g     | 10 g     |
| Yolk             | 5 g      | 5 g      | 5 g      | 5 g      | 5 g      |

### 2.3. Procedures

The procedure for making nuggets based on Statsenko *et al.* (2021), by preparing chicken, egg, water, flour, and liaison. This study was started by sorting anchovies, moringa leaves, and cassava leaves to have uniform size and color. The anchovy meat was mashed using a meat grinder, whereas moringa and cassava leaves were blended for 2 min. Next, mashed moringa and cassava leaves were mixed with wheat flour, fine anchovies, crushed garlic, pepper powder, salt, sugar, cornstarch, and water. The dough was steamed then molded in a baking sheet. The cooked nuggets were allowed

to cool, then cut into small pieces, mixed with beaten eggs, and coated with breadcrumbs. Last, the nuggets were packaged and stored for physical and chemical analysis.

## 2.4. Organoleptic Test

The organoleptic assessment of anchovy nuggets was conducted using a 5-point hedonic scale method, involving 25 panelists from Ottimmo International students aged 19 to 25 years. Every panelist get 5 nugget samples (F0-F4). The score was stored in a Google form. The assessment criteria included color, aroma, taste, and overall preference, with a numerical scale ranging from very dislike (1), dislike (2), neutral (3), like (4), to very like (5) (Farrah *et al.*, 2022).

## 2.5. Physical and Chemical Analysis

The physical parameter, namely color, was analyzed through colorimetry (Engelen, 2018). The first step was prepare sample and put it in the cuvette. Then, read absorbance and write the score. The chemical analysis in this study (Rahmah, 2021) included moisture content (using the gravimetric method), ash (using a furnace Carbolite, United Kingdom, at a temperature of 575°C for 5 h), protein (using the Kjeldahl method), fat (Soxhlet distillation method and hexane solvent (Merck, Germany)), and carbohydrates (by difference method).

## 2.6. Statistical Test

The data from the organoleptic test were analyzed using one-way ANOVA, followed by Duncan's multiple range test ( $p < 0.05$ ) to assess differences in the means for color, flavor, taste, and overall acceptability. Statistical analysis was performed using SPSS software version 25 for Windows (IBM Corp. New York, USA).

## 3. RESULTS AND DISCUSSION

The nuggets were made by substituting the primary ingredient (without adding moringa and cassava leaves) or F0, and adding variations of moringa and cassava leaves. The organoleptic properties assessed included color, aroma, texture, and flavor. Table 2 presents the results of the organoleptic test to evaluate the best acceptance of nuggets using the hedonic method. According to Table 1, the organoleptic test for all parameters showed significant differences in the substitution levels of F1, F2, F3, and F4 when compared to F0.

Table 2. Organoleptic test of anchovy nuggets with moringa and cassava leaves substitution

| Sample | Taste             | Flavor            | Color              | Overall            |
|--------|-------------------|-------------------|--------------------|--------------------|
| F0     | $3.56 \pm 0.76^c$ | $3.13 \pm 0.17^b$ | $3.17 \pm 0.640^b$ | $3.23 \pm 0.099^a$ |
| F1     | $2.82 \pm 0.05^a$ | $3.22 \pm 0.31^b$ | $3.12 \pm 0.602^b$ | $3.40 \pm 0.720^b$ |
| F2     | $3.23 \pm 0.21^b$ | $3.55 \pm 0.33^c$ | $2.59 \pm 0.098^a$ | $3.22 \pm 0.830^a$ |
| F3     | $3.22 \pm 0.82^b$ | $3.42 \pm 0.73^c$ | $3.79 \pm 0.370^c$ | $3.51 \pm 0.733^b$ |
| F4     | $2.95 \pm 0.27^a$ | $2.72 \pm 0.88^a$ | $2.78 \pm 0.790^a$ | $3.55 \pm 0.668^b$ |

Note: Significant differences are indicated by mean values followed by different superscripts in the same column ( $p < 0.05$ ).

### 3.1. Taste

The formulation of F0 ( $3.56 \pm 0.76^c$ ) was significantly different from other treatments. The taste of control nugget (F0) contains the typical anchovy with the umami flavor due to the effect of salt, sugar and a little pepper addition into anchovy nuggets. The addition of moringa and cassava leaves significantly lower the perception of panelists on the taste of anchovy nuggets. Moringa leaves have a saponin content (Majid *et al.*, 2017), which causes a bitter taste in nuggets. Cassava leaves have cyanogenic content (Putri *et al.*, 2023), which causes a bitter taste in nuggets.

### 3.2. Flavor

The addition of moringa leaves and cassava leaves up to 2 g (F1) increased the flavor of anchovy nuggets but was still not significant compared to control nuggets (without substitution of moringa leaves and cassava). The more addition of moringa and cassava leaves significantly increased the flavor of nuggets with an optimum value obtained in F2 (4 g

addition). The addition of even more moringa leaves decreased the flavor. In the F4 treatment (addition of 8 g), the decrease in nugget flavor even reached a value that was significantly lower than the control nugget. This is because moringa leaves provide an unpleasant flavor or "langu" (Alamsyah *et al.*, 2024).

### 3.3. Color

Based on Table 1, F3 treatment gets score  $3.79 \pm 0.37$  for color and was significantly different from F0, F1, F2, and F4. A significant different formulation was seen in the color parameter. It can be showed in Figure 1. The darker color of the nugget is attributed to the higher concentration of moringa and cassava leaves in the formulation. The green color of the nuggets is increasing, affected by the amount of moringa and cassava leaves addition. The green color of moringa leaves is attributed to their high content of tannins, flavonoids, and saponins. In addition, the green color of moringa leaves provides an antibacterial effect on a product (Wulandari *et al.*, 2020). Moringa leaves have been proven to contain high levels of vegetable protein in fish ball research (Isra *et al.*, 2024). Cassava leaves have an impact on alternative sources of plant-based protein on protein extraction and recovery research.

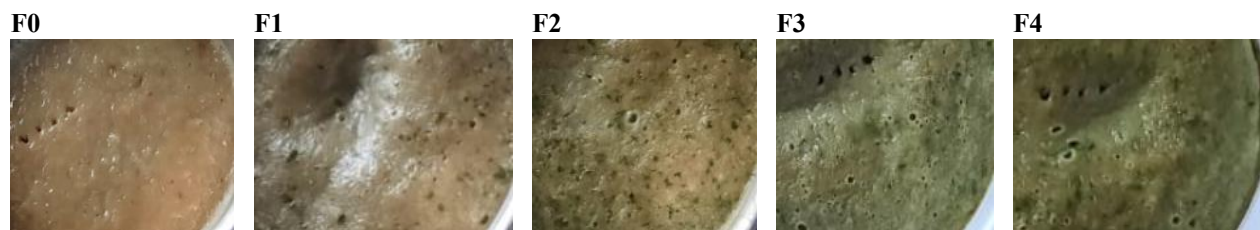


Figure 1. Anchovy nuggets with moringa leaves and cassava leaves substitution after steaming

### 3.4. Overall

Overall, the addition of moringa and cassava leaves affected on anchovy nuggets. Nuggets from F1, F3, and F4 got the higher overall score, namely  $(3.4 \pm 0.72)$ ,  $(3.51 \pm 0.733)$ , and  $(3.55 \pm 0.668)$ , respectively. They were significantly higher than those of nuggets from F0 and F2 treatments. Main factor is the color of anchovy nuggets has a bright green color. In addition, the more leaves are added, it gives an unpleasant and bitter taste. It will disappear because it is overall affected by the salt and pepper factors added to the nugget dough. Another factor is the steaming process, bread flour coating and frying which is able to eliminate the bitter unpleasant flavor ("langu") in anchovy nuggets.

Table 2. Color physical analysis of anchovy nugget

| Sample Code | Chemical Analysis      |                      |                         |
|-------------|------------------------|----------------------|-------------------------|
|             | Lightness ( <i>L</i> ) | Redness ( <i>a</i> ) | Yellowness ( <i>b</i> ) |
| F0          | $38.6 \pm 0.24^c$      | $11.9 \pm 0.77^c$    | $42.2 \pm 0.44^b$       |
| F1          | $36.0 \pm 0.87^c$      | $11.8 \pm 0.96^c$    | $42.9 \pm 1.22^b$       |
| F2          | $33.5 \pm 0.89^b$      | $10.0 \pm 1.52^b$    | $44.6 \pm 1.26^c$       |
| F3          | $31.1 \pm 0.77^b$      | $8.7 \pm 0.65^a$     | $37.7 \pm 0.97^a$       |
| F4          | $27.6 \pm 1.21^a$      | $7.4 \pm 0.67^a$     | $35.7 \pm 1.03^a$       |

Note: Significant differences are indicated by mean values followed by different superscripts in the same column ( $p \leq 0.05$ ).

### 3.5. Physical Analysis

Table 2 provides the effect of moringa and cassava leaves addition on the physical characteristic of nuggets in term of color. The color of nugget concluded that F1 without substitution has the high value of lightness (*L*), redness (*a*), and yellowness (*b*). After adding moringa and cassava showed that the color has *L*, *a*, *b* decreased significantly. Based on Table 2 and Figure 1, lightness of F4 ( $27.6 \pm 1.2113$ ) was the lowest, meaning the darkest. The addition of moringa and cassava leaves also decrease significantly the redness value, especially with addition of  $\geq 4$  g. The addition of moringa and cassava leaves, however, is initially increase the yellowness value up to the maximum of  $(44.6 \pm 1.26)$ , but more addition decreased the yellowness value.

Table 3. Effect of moringa and cassava leaves substitution on the chemical value of anchovy nuggets (% BB)

| Sample Code | Chemical Analysis        |                         |                          |                          |                          |
|-------------|--------------------------|-------------------------|--------------------------|--------------------------|--------------------------|
|             | Water content (%)        | Ash content (%)         | Protein (%)              | Fat (%)                  | Carbohydrate (%)         |
| F0          | 38.34±0.311 <sup>c</sup> | 3.24±0.042 <sup>a</sup> | 8.87±0.056 <sup>a</sup>  | 16.81±3.337 <sup>c</sup> | 16.39±0.105 <sup>a</sup> |
| F1          | 32.93±0.753 <sup>b</sup> | 3.48±0.036 <sup>b</sup> | 9.12±0.075 <sup>a</sup>  | 15.10±0.169 <sup>b</sup> | 19.29±0.208 <sup>b</sup> |
| F2          | 31.63±0.261 <sup>b</sup> | 3.70±0.090 <sup>c</sup> | 10±0.1.253 <sup>b</sup>  | 14.44±0.248 <sup>b</sup> | 20.57±0.368 <sup>c</sup> |
| F3          | 31.45±0.238 <sup>b</sup> | 3.97±0.076 <sup>c</sup> | 10.23±0.085 <sup>b</sup> | 13.70±0.266 <sup>a</sup> | 20.65±0.172 <sup>c</sup> |
| F4          | 28.85±0.851 <sup>a</sup> | 3.43±0.053 <sup>b</sup> | 11.81±0.030 <sup>c</sup> | 13.23±0.065 <sup>a</sup> | 20.51±0.144 <sup>c</sup> |

Note: Significant differences are indicated by mean values followed by different superscripts in the same column ( $p \leq 0.05$ ).

### 3.6. Chemical Characteristic

Table 3 presents the chemical characteristics of anchovy nuggets supplemented with cassava and moringa leaves at different composition.

#### 3.6.1. Water Content

Table 3 demonstrates that the addition of cassava and moringa leaves has significantly decreased on the moisture content of anchovy nuggets. The lowest moisture content of anchovy nuggets was in the range of 28.85±0.8513 and was significantly different from the other treatment. The water content value of anchovy nuggets has met the requirements of SNI 6683:2014 regarding chicken nuggets with a maximum moisture content of 50%. Along with the many substitutions of moringa leaves and cassava leaves, it has an effect on decreasing the water content value of anchovy nuggets. This is influenced by the added leaf starch content, the more moringa leaves adding, the water content decreases and the crude fiber increase (Suhaemi *et al.*, 2021). Another factor that affects anchovy nuggets decrease in water content is presence of moringa. Moringa have a lower moisture content (Dwiani & Yuniartini, 2022).

#### 3.6.2. Ash Content

The ash content value of anchovy nuggets was significantly influenced by the amount of cassava and moringa leaf substitution. Ash content is a mixture of inorganic or mineral components found in processed foods. The average value of the smallest ash content was 3.24±0.0416<sup>a</sup> in the control treatment (without moringa and cassava levae addition). The average value of the highest ash content was F3 (3.97±0.0763) with additional moringa 6 g and cassava leaves 6 g. The more leaves of moringa cassava are added, the higher the ash content value (Yuniastuti *et al.*, 2021). This is due to the mineral content (inorganic substances) in moringa leaves and cassava leaves. There is mineral content of moringa and cassava leaves such as P, S, K, Ca, Ti, Cr, Mn, Fe, Ni, Cu, Zn, Mo, Sr, Ba, and Re (Alghafari & Shofi, 2018).

#### 3.6.3. Protein

The protein content of anchovy nuggets was positively influenced by the treatment ratio of cassava and moringa leaf substitution, as shown by the chemical analysis results. Based on the Table 3, F4 (11.81±0.03) was significantly different from each other. Protein consumption affects the performance of the IGF-1 hormone or known as somatomedin. The hormone somatomedin, a polypeptide protein hormone that has an insulin-like molecular structure that acts as a mediator (Booy *et al.*, 2022) growth hormone. This research is in accordance with the main goal, which is to create anchovy nuggets to prevent stunting. Nuggets are a favorite food for children and adults alike. These nuggets are suitable for vegetarians, children who have difficulty eating vegetables, either as a snack or as a side dish for rice friends. Apart from being easy to get, it tastes good and how to consume it is relatively easy. Meanwhile, cassava and moringa are cheap and affordable to get and utilization is still lacking. The extracted protein of cassava can be utilized in various food applications, providing a sustainable and potentially nutritious ingredient for both human and animal nutrition (Miranda *et al.*, 2024).

#### 3.6.4. Fat

The results of chemical analysis from Table 3 showed that the ratio of moringa and cassava were affected on the fat value of anchovy nuggets. The control treatment on F0 gave the highest fat content value of 16.81±3.337 and F4 with

the lowest fat content value of  $13.23 \pm 0.065$ . Moringa leaves have bioactive content, phytochemicals and saponins that are able to reduce the total cholesterol content of food products (Vázquez-León *et al.*, 2017). High cholesterol levels have an impact on the risk of cardiovascular disease. Consumption of anchovy nuggets with the substitution of moringa leaves and cassava leaves provides good benefits because it contains low fat content.

### 3.7. Carbohydrates

The ratio of cassava leaves and moringa leaves has a significantly different protein value for anchovy nuggets. The control treatment on anchovy nuggets had a carbohydrate value of  $16.39 \pm 0.1053$ . The highest carbohydrate value in F3 was  $20.65 \pm 0.1721$ . Treatments F2, F3, and F4 were significantly different from F0 and F1. The addition of moringa and cassava leaves contribute on the Carbon (C), Hydrogen (H), and Oxygen (O) elements which are main elements composing the carbohydrates. Carbohydrates are nutrients that play a role in producing the main energy in the body (Yunita *et al.*, 2022). It was important for children growth and healthy. There is correlation between carbohydrates and stunting for toddler to complement their macronutrients (Rahmadani *et al.*, 2019). This research based on the goal that effort to prevent stunting.

## 4. CONCLUSION

The supplementation of moringa and cassava leaves into the anchovy nuggets resulted in significantly different physical and chemical characteristic of the anchovy nuggets. Addition of moringa and cassava leaves in general decreased the color of the nuggets, especially the lightness and redness. Organoleptic assessment confirm the general trend of decreasing color, except the addition of 6 g leaves (F3), which got the highest organoleptic score for color attribute. The addition of moringa and cassava leaves up to 6 g (F3) resulted in the higher organoleptic score for flavor, color, and overall attributes, except for taste which is lower than that of control (F0). More addition of these leaves resulted in unpleasant flavor. Based on chemical compositions, supplementation of moringa and cassava leaves improved the characteristic of anchovy nuggets by increasing protein and carbohydrate content while decreasing fat and water content. The results of the chemical test on anchovy nuggets gave the best value in F4 with protein content of  $11.81 \pm 0.030\%$ , fat of  $13.23 \pm 0.065\%$ , and carbohydrate of  $20.51 \pm 0.144\%$ . Based on organoleptic test, however, high leaves addition resulted in unpleasant flavor (“langu”). Therefore, the addition of 6 g for each moringa and cassava leaves into anchovy nuggets is recommended. This research proven that anchovy nuggets with cassava and moringa leaves supplementation have the improved nutritional value that can be employed to prevent stunting.

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