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ORGANOLEPTIC ANALYSIS, QUALITY REQUIREMENT, AND COLOR DETERMINATION OF TILAPIA NUGGETS WITH *Eleutherine palmifolia* EXTRACT COATING

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Abstract. *Nuggets are a product that should be stored frozen, but nuggets are often sold at inappropriate temperatures, causing physical changes such as pale color. Dayak onion extract can improve color appearance and provide added antioxidant value to tilapia nuggets. Quality testing of tilapia nuggets with Eleutherine palmifolia (Dayak onion) extract coatings has been investigated. The objectives of this research are to apply Dayak onion extract to improve the appearance of tilapia nuggets and to obtain tilapia nuggets with Dayak onion extract that meets SNI requirements. The results of organoleptic tests showed that panelists preferred tilapia nuggets with Dayak onion extract over commercial controls and nuggets. The panelists preferred tilapia nuggets with 100 ppm ethanol extract and 10000 ppm aqueous extract, both continued to the SNI conformity test. The sensory evaluation results based on SNI showed that the appearance of the tilapia nuggets with 100 ppm ethanol extract was significantly different. Adding Dayak onion extract to tilapia nuggets affected the lightness and yellowness of tilapia nuggets and gave a 'moderate orange' color to the tilapia nuggets with ethanol and aqueous extract. The selected tilapia nugget with 100 ppm aqueous Dayak onion extract meets all chemical, microbiological, and sensory requirements as SNI 7758:2013 concerning fish nuggets. Tilapia nuggets with Dayak onion extract had a brighter Moderate orange color and were preferred by panelists compared to controls and commercial fish nuggets that were moderate dark orange. Applying Dayak onion extract on tilapia nuggets can improve the appearance and it potentially contains natural antioxidants.*

Keywords: *Eleutherine palmifolia*; organoleptic; tilapia nugget; food quality; Dayak onion.

1. Introduction

Tilapia fish nugget is one of the processed fishery products that is much preferred by consumers. It is practical and is marketed in a frozen state so that it has a long shelf life. Tilapia nuggets can be a source of protein for consumers. Sales of frozen food in markets are often carried out at room temperature. Frozen products are displayed in a frozen showcase where the temperature is controlled below -18 ^{o}C (BPOM, 2021). Inappropriate storage can cause damage to the nuggets due to the growth of microorganisms and damage to the texture of the nuggets. The thawing process can cause water to come out of the product (drip). Drip causes several nutrients such as salts, polypeptides, amino acids, lactic acid, purines, and others that dissolve in water to be carried away with the water that comes out of the nuggets (Nento & Ibrahim, 2017). This causes changes in the texture of the nuggets. Storing nuggets at room temperature also causes changes in

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nugget color. The change in nugget color from orange to brownish can be caused by microbial growth and temperature (Amiroh & Syah, 2017).

Tilapia nuggets that are circulated in the market must be ensured according to the specified requirements. The quality and food safety requirements of fish nuggets in Indonesia are regulated in SNI 7758:2013, which requires a minimum product sensory value of 7 (seven). Good fish nuggets have a dry and bright layer of breadcrumbs (BSN, 2013). Color is one of the essential attributes of meat products because it is directly related to consumer acceptance (Hafid *et al*., 2021). Adding Dayak onion extract with various concentrations to tilapia nugget coating potentially improves its color, appearance, and antimicrobial ability. Adding Dayak onion extract to food products influences the product's characteristics and antioxidant content. Dayak onions (*Eleutherine palmifolia*) are one of the plants known to have antioxidant (Febrinda *et al*., 2014), anti-inflammatory (Paramita & Nuryanto, 2019; Insanu *et al*., 2014), antibacterial (Harlita *et al*., 2018; Insanu *et al*., 2014), anti-hypertension (Rauf *et al*., 2018), inhibitor of α-glucosidase and HIV replication (Insanu *et al*., 2014), and colon anticancer abilities (Mutiah *et al*., 2020). Dayak onions belong to the *Iridaceae* family and have long been used by ethnic Dayaks in Borneo as a traditional medicine for various types of diseases such as breast cancer, high blood pressure (hypertension), diabetes mellitus, cholesterol-lowering, heart disease, and stroke (Kuntorini *et al*., 2016). *Eleutherine palmifolia color* extract is brownish-red because it contains anthocyanins with antioxidant activity (Ekawati & Saputri, 2021).

Adding Dayak onion extract can improve the sensory and food safety of homemade salad dressing (Ifesan *et al*., 2009a). Dayak onion extract is known to increase the value of redness and promising as a natural antioxidant and color enhancer (Ifesan *et al*., 2009b). Dayak onion extract on nuggets has been applied to duck, chicken (*Gullus turcicus*), and catfish nuggets. Adding Dayak onion extract affects catfish nuggets' antioxidant activity and flavonoid content (Rohman *et al*., 2020). In addition to antioxidant activity, Dayak onion extract affects the organoleptic quality of duck nuggets (Hidayat *et al*., 2022). However, Dayak onion extract decreases the color quality of chicken nuggets (Ismanto *et al*., 2017). Mixing Dayak onion extract into nuggets causes the nuggets to become red. Therefore, improving the color quality of nuggets can be done through extract coating. Coating the extract also aims to maintain the antioxidant activity of Dayak onions in nuggets. Organoleptic analysis is commonly used to assess the quality of a product using the human senses and was used to assess consumer acceptance of tilapia nuggets, and the best treatment was selected by statistical analysis. Sensory evaluations can determine the organoleptic quality of fish or a fish product for various attributes such as appearance, flavor, odor, and texture (CFIA, 2020). The objectives of this research are to apply Dayak onion extract to improve the

appearance of tilapia nuggets, using organoleptic analysis to determine the selected formula that will be continued for conformity testing with SNI.

2. Methods

2.1. Materials

In this study, ingredients for making tilapia nuggets consisted of tilapia fillets, tapioca, garlic, water, ice cubes, white pepper, salt, mushroom broth, wheat flour, breadcrumbs, and vegetable oil. The dry coating process used corn starch. The process continued with wet coating using Dayak onion extract and wheat flour. The last layer used breadcrumbs flour until all parts of the nugget were covered. All the ingredients for making tilapia nuggets were purchased from the local market in Bogor. Dayak onions were purchased from local farmers in Samarinda, East Kalimantan.

2.2. Extraction of Dayak Onion

Dayak onion bulbs were sorted, washed, thinly sliced and dried in a food dehydrator at 50 ^{o}C for 6-7 hours. Dayak onion simplicial was sieved with a 60-mesh size. Dayak onion powder was extracted with water or ethanol solvents each in a ratio of 1:5, carried out twice with ultrasonic (Vevor, Canada) assistance. Dayak onion extract was thickened using a rotary evaporator (Heidolph, Germany) to obtain a dry extract, then it was dissolved with water to a concentration of 50,000 ppm. The extract was then diluted to 100, 1000, and 10,000 ppm.

2.3. Nuggets Coating

Tilapia nugget consists of fish fillets, tapioca, seasonings, mushroom broth, pepper, water, ice cubes, and cooking oil. Fish fillets and all ingredients were mashed with a food processor until a dough was formed. The dough was then steamed. After steaming, the nuggets were molded, and coating was carried out. The first layer was pre-dusting using cornstarch, and the second was battering, utilizing a mixture of Dayak onion extract of each concentration with wheat flour (3:1). Then, the third layer used yellow breadcrumb until the overall nugget was evenly covered. After that, nuggets were stored in the freezer at -18 ^{o}C for 1 hour and packed with LDPE plastic. Frozen storage was necessary for this product.

2.4. Organoleptic Test and Analysis

Thirty untrained panelists carried out the organoleptic test of tilapia with hedonic tests. A total of 7 samples were coded differently and presented to the panelists for assessment of the parameters of color, aroma, taste, texture, appearance, and overall. Scoring was done using 1-5 scale i.e., 5 = very like; 4 = likes; 3 = neutral; 2 = dislike; 1 = very dislike. Panelists assessed spontaneously without comparing the samples. The sample with the most preferred treatment of panelists was tested again on ten semi-trained panelists according to the standard of SNI 7758:2013.

2.5. Quality Conformity

Tilapia nuggets with Dayak onion extract coating with the best treatment based on the results of organoleptic analysis tested several quality parameters according to the requirements listed in the Indonesian National Standardization (SNI) 7758:2013 concerning fish nuggets. The quality requirements of fish nuggets consist of sensory, chemicals comprised of water, protein, ash, fat, and microbiological quality, including total plate count (TPC) and *Staphylococcus aureus* count.

2.6. Color Determination and Analysis

Color determination of tilapia nuggets was performed using Chromameter (FRU WR 10-8, China). The measurement results were L (brightness), a (reddish) and b (yellowish) values. After that, the L, a, and b values were interpreted using ColorHexa.com software.

2.2. Experimental Methods

In this study, the research stages consisted of making extracts, applying extracts at the tilapia nugget coating, a hedonic test of tilapia nuggets, color measurement with a chromameter, conformity test with SNI 7758: 2013, as well as selection of the best treatment. The product with the best treatment was then carried out with a proximate analysis and total plate count (TPC). The sample consisted of raw nuggets and cooked nuggets. In this study, the treatment was carried out as follows: A100 (Nuggets coated with aqueous extract 100 ppm), A1000 (Nuggets with coated aqueous extract 1000 ppm), and A10000 (Nuggets coated with aqueous extract 1000 ppm); B100 (Nuggets coated with ethanolic extract 100 ppm), B1000 (Nuggets coated with ethanolic extract 1000 ppm), and B10000 (Nuggets coated with ethanolic extract 1000 ppm); C (Nuggets without extract coating); D (Commercial fish nuggets). The results were expressed as a mean ± SD. The statistical analysis was carried out using one-way ANOVA followed by DMRT post hoc test. P value < 0.05 was statistically significant. Data analysis was processed statistically using SPSS IBM version 23 software.

3. Results and Discussion

3.1. Antioxidant activity

Tilapia nuggets coated with *Eleutherine palmifolia* extracts are known to have antioxidant activity. The results of antioxidant tests on tilapia nuggets coated with water extract and Dayak onion ethanol can be seen in Figure 1. The test results showed that the antioxidant activity of tilapia nuggets with Dayak onion ethanol extract coating was more significant than tilapia nuggets with Dayak onion water extract coating. In line with Febrinda *et al*. (2022), the effective dose of Dayak onion water extract is greater than ethanolic extract in inhibiting the action of alpha-glucosidase enzymes. It shows that ethanol extract has a higher ability than aqueous extract to inhibit the activity of alpha glucosidase enzyme. Phytochemical analysis shows that Dayak onion ethanol

extract contains flavonoids, tannins, saponins, phytosterols and phenols (Anggi & Maghfirah, 2019). Dayak onion powder contains polyphenol and flavonoid compounds which are often referred as natural antioxidants, both of which work together to ward off free radicals (Hendrawan *et al.*, 2020). Antioxidants in nuggets coated with Dayak onion extract are lower than pure Dayak onion extract. This is caused by several factors including further processing of the product and the concentration used. In cooked pork, Dayak onion extract showed antioxidant activity that increased along with increasing extract concentration and slowed lipid oxidation (Ifesan *et al.*, 2009a). The antioxidant activity of *Eleutherine palmifolia* extract shows certain nutritional value, making it potential as a source of natural antioxidants.

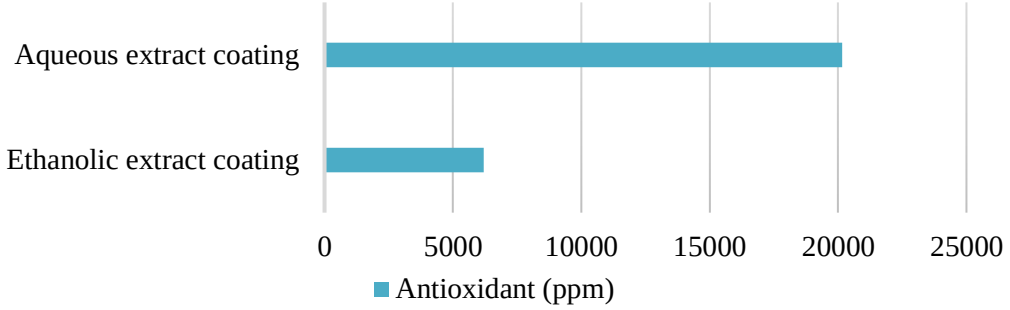

Figure 1. Antioxidant activity of tilapia nuggets

3.2. Organoleptic evaluation

The hedonic test of tilapia nuggets with *Eleutherine palmifolia* extracts coating was performed by 30 panelists using a response form. The sample consisted of tilapia nuggets coated with ethanol extract (3 concentrations, "A" codes), tilapia nuggets coated with an aqueous extract (3 concentrations, "B" codes), one nugget without extract coating (control, "C" code) and one commercial fish nugget ("D" code). Testing was carried out on samples of raw nuggets and cooked nuggets. Table 1 describes the results of the hedonic test of raw tilapia nuggets with *Eleutherine palmifolia* extracts, and Table 2 describes cooked tilapia nuggets.

Table 1. The hedonic test result of raw Tilapia nuggets

Samples	Color	Aroma	Texture	Overall
A100	3.90 ± 0.80^{de}	3.60 ± 0.77^{b}	3.60 ± 0.86^{bc}	3.83 ± 0.83^{cd}
A1000	4.20 ± 0.78^{e}	3.47 ± 0.97^{bc}	3.50 ± 1.01^{c}	3.63 ± 0.96^{d}
A10000	3.83 ± 1.05^{de}	4.03 ± 1.00^{b}	3.57 ± 1.07^{bc}	3.57 ± 0.97^{cd}
B100	3.23 ± 1.04^{bc}	3.40 ± 1.10^{b}	3.60 ± 1.04^{bc}	3.37 ± 1.00^{b}
B1000	3.57 ± 0.86^{cd}	3.43 ± 0.97^{b}	3.63 ± 0.8^{bc}	3.60 ± 0.81^{bcd}
B10000	3.70 ± 0.75^{d}	3.40 ± 1.04^{b}	3.60 ± 1.00^{bc}	3.70 ± 0.84^{bcd}
C	3.10 ± 0.96^{b}	3.47 ± 0.94^{b}	3.17 ± 1.05^{b}	3.47 ± 0.94^{bc}
D	1.93 ± 0.78^{a}	2.23 ± 1.01^{a}	2.33 ± 1.12^{a}	2.00 ± 0.79^{a}

Note: Data are presented as the means of thirty panelists ± standard deviation. Different superscripts in one column showed significantly different ($p<0.05$) using Duncan Multiple Ranges Test (DMRT).

The organoleptic test used in this part of research was the hedonic test. Parameters tested included product color, aroma, taste, and texture. The hedonic test of tilapia nuggets with *Eleutherine palmifolia* extracts coating was performed by 30 panelists using a response form. The sample consisted of tilapia nuggets coated with ethanol extract (3 concentrations, "A" codes), tilapia nuggets coated with an aqueous extract (3 concentrations, "B" codes), one nugget without extract coating (control, "C" code) and one commercial fish nugget ("D" code). Testing was carried out on samples of raw nuggets and cooked nuggets. Table 1 describes the results of the hedonic test of raw tilapia nuggets with *Eleutherine palmifolia* extracts, and Table 2 describes cooked tilapia nuggets.

Table 2. The hedonic test result of cooked Tilapia nuggets

Samples	Color	Taste	Aroma	Texture	Overall
A100	4.10 ± 0.80^{c}	4.17 ± 0.91^{d}	3.63 ± 0.76^{c}	3.60 ± 1.00^{b}	3.93 ± 0.78^{c}
A1000	4.07 ± 0.78^{c}	$3.63\pm0.96b^{c}$	3.47 ± 0.97^{bc}	3.50 ± 1.01^{b}	3.63 ± 0.96^{bc}
A10000	4.03 ± 0.81^{c}	3.50 ± 1.17^{bc}	3.53 ± 1.01^{c}	3.63 ± 0.96^{b}	3.57 ± 0.97^{bc}
B100	3.67 ± 0.88^{c}	3.10 ± 0.80^{ab}	3.03 ± 0.72^{ab}	3.10 ± 1.11^{a}	3.30 ± 0.79^{b}
B1000	3.17 ± 0.95^{b}	3.43 ± 1.07^{bc}	3.37 ± 0.96^{bc}	$3.70\pm1.11a^{b}$	3.50 ± 1.07^{bc}
B10000	3.67 ± 0.76^{c}	3.67 ± 1.12^{c}	3.57 ± 0.97^{c}	3.67 ± 0.92^{b}	3.77 ± 1.01^{bc}
C	4.03 ± 0.85^{c}	3.47 ± 0.78^{bc}	3.47 ± 0.90^{bc}	3.33 ± 0.76^{ab}	3.40 ± 0.67^{b}
D	2.77 ± 0.97^{a}	2.80 ± 1.13^{a}	2.87 ± 0.97^{a}	3.03 ± 0.93^{a}	2.87 ± 1.11^{a}

Note: Data are presented as the means of thirty panelists ± standard deviation. Different superscripts in one column showed significantly different ($p<0.05$) using Duncan Multiple Ranges Test (DMRT).

3.2.1 Color

Color is a critical quality parameter determining consumer perception of products, including nuggets. Based on hedonic tests, the color of raw and cooked commercial fish nuggets (D) was the least liked. Meanwhile, Tilapia nuggets with Dayak onion extract (A and B) were relatively preferred over control tilapia nuggets (C). The results in Table 1 showed that the score of consumer preference for tilapia nuggets color (A and B) significantly different ($P<0.05$) from control (C). Cooked tilapia nuggets were relatively different from raw tilapia nuggets on the result of the hedonic test. In raw tilapia nuggets, coated nuggets with 1000 ppm ethanol extract were the most significantly different ($P<0.05$). Compared to control and commercial fish nuggets, the average score showed that panelists mostly favored coated nuggets. The addition of Dayak onion extract made the color of tilapia nuggets brighter. The yellow brown color was preferred over dark brown in cooked tilapia nuggets. In line with Ifesan *et al.* (2009b), the addition of the extract caused an increase in the redness value of the pork, and this was acceptable from a sensory point of view.

In cooked tilapia nuggets, coated nuggets with 1000 ppm aqueous extract were most significantly different ($P<0.05$). Tilapia nuggets coated with ethanol extract 100 and 1000 ppm were more preferred by panelists. The yellow brown color of cooked tilapia nuggets was more preferred to dark-brown ones. Fried foods are generally brownish due to the Maillard reaction. The

Maillard reaction involves a change in the color and taste of the meat. It is an organic chemical reaction. In this organic reaction, sugars and amino acids react with each other (Hosen *et al*., 2021). Based on the overall hedonic test results of raw and cooked tilapia nuggets, it was found that the panelists liked nuggets coated with Dayak onion extract. However, the color produced by the two was different; nuggets with water extract would be darker than the coating of Dayak onion ethanol extract. Thus, Dayak onion extract can be a potential natural color enhancer in meat products.

3.2.2 Aroma

The hedonic test of aroma parameters showed that commercial fish nuggets significantly differed in raw and cooked nuggets ($P<0.05$). There was no difference in aroma between control and coated nuggets with Dayak onion extract in raw tilapia nuggets. Likewise, similar result was found on cooked tilapia nuggets. It showed that adding water or ethanol extract from Dayak onions did not affect the fishy aroma of tilapia nuggets. The average hedonic test score showed panelists rated the smell of tilapia nuggets coated with Dayak onion extract, which was neutral to like. Based on the results of the sensory test, the aroma preferred by the panelists was tilapia nuggets with a higher concentration of Dayak onion extract, both in raw and cooked nuggets. However, in contrast to research results (Hidayat *et al*., 2022), the aroma of cull duck meat nuggets decreased in score as the Dayak onion extract was added (max. 3%). This is because the concentration used in this study was still lower, namely a maximum of 10,000 ppm (1%). Dayak onions have odor compounds from aldehyde-ketone derivatives, namely aromatic aldehydes (Saputra & Eldha, 2007).

3.2.3 Texture

Based on hedonic tests of texture parameters, raw commercial fish nuggets were significantly different ($P<0.05$). However, the texture was the same in all samples in cooked tilapia nuggets. Dayak onion extract did not affect the texture of tilapia nuggets. The texture of the nuggets is influenced using fish meat and binders. On tilapia nuggets, tapioca flour is used as a binder. Tapioca flour contains amylose and Amylopectin that affect the texture of dense and chewy nuggets. Amylose content in starch significantly affects (Subroto *et al*., 2020). In line with research results by Hidayat *et al.* (2022), the addition of onions Dayak up to 3% in rejected duck nuggets did not make a significant difference due to the differences in texture of all treatments were relatively small. The addition of Dayak onions to the nuggets in this study was not intended to soften the texture but was more focused on increasing the color and adding natural antioxidants to the tilapia nuggets.

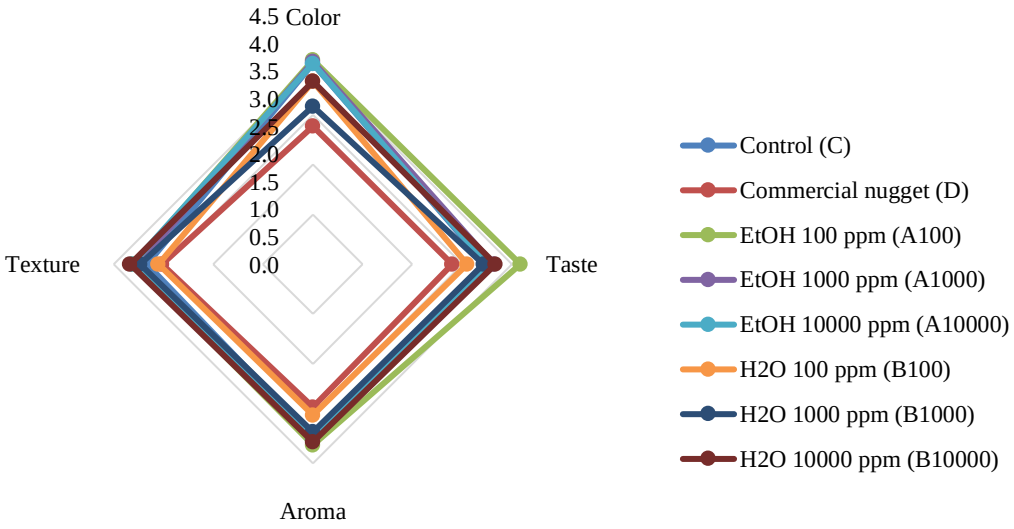

Figure 2. The spider web of tilapia nuggets of all parameters

3.2.4 Overall

The panelist's average score against all hedonic test parameters can be seen in Figure 2. From the spider web of several parameters on cooked nuggets, the ones with the highest average hedonic score are tilapia nuggets coated with 100 ppm Dayak onion ethanol extract (A100), followed by nuggets coated with 10000 ppm Dayak onion water extract (B10000). Both samples have the largest spider web area. This shows that both are the best treatments that were most preferred by the panelists. These two samples were selected to proceed to the next stage, namely the SNI conformity test.

3.3 *Quality conformity* with SNI

The quality conformation test of tilapia nuggets was carried out based on the Indonesian National Standardization (SNI 7758:2013) concerning fish nuggets. Tests carried out included sensory tests and chemical and microbiological tests. In sensory testing using predetermined parameters with a score range of 3-9, panelists filled out a test form, as shown in Table 3. In this sensory test, 15 trained panelists were used. Chemical and microbiological tests were performed on selected samples that qualify with sensory requirements on SNI. Based on the results of the sensory test of conformity with SNI, results were obtained as in Table 4.

The results on all samples based on taste, texture, and aroma parameters were not significantly different. Only on the appearance parameter were all samples were significantly different ($P<0.05$). The appearance of tilapia nuggets with a 100 ppm Dayak onion ethanol extract coating had an average score of 9.00, which means the A100 had a dry breadcrumb layer and a bright color appearance. Followed by nugget control with 7.62 scores, it had dry breadcrumbs and a less bright color appearance. The average appearance score of B10000 was 6.69, with dry breadcrumbs with a slightly dark brown. Tilapia fish nuggets had a white color on the inside and

a red layer on the outside followed by the orange color of the breadcrumbs. There was a significant difference between nuggets coated with water extract and ethanol extract. Nuggets coated with water extract had a darker color than ethanol extract. The use of 100 ppm of Dayak onion ethanol extract was preferable to 10,000 ppm of aqueous extract. Dayak onion contains high pigment of anthocyanin natural colorant (Fal *et al*., 2018). The higher the concentration of Dayak onion extract used, the darker the color of the tilapia nuggets produced. Apart from that, differences in solvents during the extraction process also have an influence. Dayak onion ethanol extract has more phytochemical compounds than aqueous extract such as alkaloids, tannins, phenolics, flavonoids and triterpenoids. Meanwhile, Dayak onion aqueos extract contains alkaloids, phenolics and triterpenoids (Febrinda *et al*., 2013).

Table 3. Sensory test sheet based on SNI 7758:2013

Specification	Score	Samples Code		
		742	876	919
1. Appearance				
Dry breadcrumb and bright colours	**9**			
Dry breadcrumb and less bright colours	**7**			
Wet breadcrumb and slightly dull colours	**5**			
Wet breadcrumb and dull colours	**3**			
2. Aroma				
Strong, typical nuggets	**9**			
Less strong, typical nuggets	**7**			
Musty	**5**			
Sour and rancid	**3**			
3. Texture				
Solid, compact	**9**			
Rather dense, rather compact	**7**			
A bit mushy	**5**			
Soft	**3**			
4. Taste				
Strong, typical nuggets	**9**			
Less strong, typical nuggets	**7**			
A bit sour	**5**			
Sour	**3**			
Information: 742 = A100; 876 = B10000; 919 = control				

Table 4. Sensory evaluation based on SNI 7758:2013

Samples	Parameters			
	Appearance	Aroma	Texture	Taste
Control	7.62 ± 1.26^{a}	8.38 ± 0.96^{a}	8.08 ± 1.32^{a}	8.08 ± 1.04^{a}
A100	9.00 ± 0.00^{b}	7.62 ± 1.71^{a}	8.38 ± 0.96^{a}	8.08 ± 1.04^{a}
B10000	6.69 ± 1.11^{c}	8.23 ± 1.01^{a}	8.38 ± 1.26^{a}	8.38 ± 0.96^{a}

Note: Data are presented as the means of fifteen panelists ± standard deviation. Different superscripts in one column showed significantly different ($p<0.05$) using Duncan Multiple Ranges Test (DMRT).

Based on SNI 7758:2013, the limit score for receiving the sensory value of fish nuggets is 7. The A100 has more than seven scores and the highest average score across all parameters, so it

proceeded to chemical and microbiological tests. The results of the analysis can be seen in Table 5. The test results show that all chemical and microbial parameters of A100 meet the requirements of SNI. Some components of Dayak onion extracts, such as eleuthinone A, eleuthraquinone A, and eleuthraquinone B, as well as eleucanarol, have been successfully isolated and studied for their antibacterial activity against *Staphylococcus aureus* (Limsuwan & Voravuthikunchai, 2013). Therefore, tilapia nuggets coated with 100 ppm Dayak onion ethanol extract can be developed. Dayak onions have the potential as a natural ingredient that can provide antioxidants (Paramita & Nuryanto, 2019). The addition of ethanol extract may increase panelists' acceptance of its appearance. The results of organoleptic tests of tilapia nuggets treated with Dayak onion extract showed that adding Dayak onion extract did not affect the aroma, taste, and texture. However, the color parameters and the Dayak onion extract's appearance greatly influenced the panelists' reception. Therefore, color analysis using a chromameter is required.

Table 5. Result of chemical and microbiological test on selected sample (A100) compared with SNI

Parameter	Sample A100	Standard	Conformity
Water content (%)	57.60 ± 0.44	Max. 60	Compliance
Total ash (%)	1.76 ± 0.03	Max. 2.5	Compliance
Protein (%)	10.21 ± 0.03	Min. 5	Compliance
Total fat (%)	1.61 ± 0.03	Max. 15	Compliance
Carbohydrate (%)	28.83 ± 0.41	-	-
TPC (CFU/g)	3.7×10^3	Max. 5×10^4	Compliance
S. aureus (CFU/g)	0	Max 1×10^2	Compliance
Sensory	8.27 ± 0.50	Min. 7	Compliance

Note: Data are presented as the means of triplicates ± standard deviation.

3.4. Effect of extract on color change

Food quality depends on several factors: taste, color, and nutritional value. However, before other factors are considered, visually, the color factor comes first and sometimes is decisive. In addition to the factors determining quality, color can also be used as an indicator of the freshness or ripeness of a product (Ifesan *et al*., 2009a). Color determination of raw tilapia nuggets was done using chromameter followed by interpretation of L*, a*, b* with ColorHexa software. Color test results can be seen in Table 6.

Based on Table 6, there is a decreasing trend in the brightness value (L) of tilapia nuggets with increasing concentration of Dayak onion extract, both ethanol extract and water extract. The decrease in the L value shows that the higher the concentration of Dayak onion extract used as a coating for tilapia nuggets, the darker the nugget color. Coating nuggets with Dayak onion extract also affected the redness value (a), because Dayak onion extract has a red-brown color. The use of

Dayak onion extract significantly increases the redness value of cooked pork so that Dayak onion extract has the potential to be a natural coloring agent for meat products (Ifesan *et al*., 2009b).

Table 6. The color test result of raw tilapia nuggets

Samples	L	a	b
100	58.48±0.15^{a}	13.61±0.10^{a}	40.01±0.18^{a}
A1000	58.57±0.38^{b}	10.27±0.03^{b}	33.86±0.11^{b}
A10000	55.22±0.15^{b}	11.80±0.11^{c}	31.96±0.04^{c}
B100	64.07±0.12^{b}	11.11±0.04^{d}	35.20±0.16^{d}
B1000	59.95±0.26^{c}	8.47±0.07^{e}	27.73±0.18^{e}
B10000	58.81±0.36^{d}	10.27±0.02^{a}	29.03±0.17^{f}
C	59.72±0.27^{d}	5.51±0.05^{f}	19.13±0.04^{g}
D	67.15±0.81^{e}	6.14±0.12^{g}	25.26±0.11^{h}

Note: Data are presented as the means of triplicates determination ± standard deviation. Different superscripts in one column showed significantly different ($p<0.05$) using (DMRT).

Color information from ColorHexa results in Table 7 showed that adding 100 ppm aqueous and ethanol extracts produced a *moderate orange* nugget. In contrast, adding 1000 and 10000 ppm extracts produced a *dark moderate orange* color. Adding Dayak onion extract as a coating affected the color of tilapia nuggets. Dayak onions contain natural coloring agents, namely anthocyanins, which is one of the flavonoid group compounds (Saragih *et al*., 2014). Changes in pH cause discolorations in the extract where the acid pH of the Dayak onion extract tends to be colorless to yellow, while at the alkaline pH, the extract tends to be brownish red (Santi *et al.*, 2020). Color is an important visual cue involved in consumers' perceptions of acceptable meat quality (Faustman & Cassens, 1990) and attractive food colors can lead to increased consumption.

Table 7. Color information from ColorHexa.com

Samples	Color Information	Color Description
A100		Moderate orange
A1000		Dark moderate orange
A10000		Dark moderate orange
B100		Moderate orange
B1000		Dark moderate orange
B10000		Dark moderate orange
C		Mostly desaturated dark orange
D		Slightly desaturated orange

4. Conclusions

Based on the results of this research, *Eleutherine palmifolia* ethanol extract can improve the color and appearance of tilapia nuggets. Panelists' responses based on sensory tests showed that the extract was well accepted as a coating for tilapia nuggets. The best formula resulting from this

research is coating tilapia nuggets with 100 ppm Dayak onion ethanol extract which has a moderate orange color. This formula meets the Indonesian National Standard (SNI 7758:2013). Furthermore, Dayak onion extract can be a natural coloring for tilapia nuggets and has the potential to provide antioxidant effects. However, it still needs to be studied more deeply regarding the antimicrobial effects and shelf life of the product.

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