

THE LIMIT OF RED SEAWEED (*Eucheuma cottonii*) SUBSTITUTION IN SNAKEHEAD FISH (*Channa striata*) NUGGETS BASED ON SENSORY EVALUATION

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ABSTRACT

Snakehead fish (*Channa striata*), a freshwater fish, is known to have functional properties in helping the process of healing burns and wounds after surgery. Besides that, the use of seaweed as a source of food fiber is also widely reported. This research was conducted to design fiber-rich fish nuggets. The purpose of this study was to determine the maximum levels of seaweed substitution in the processing of snakehead fish nuggets based on sensory properties. Single-factor experiment (seaweed, *Eucheuma cottonii*, substitution) arranged in a Completely Randomized Design with four replications was applied in this study. The parameters observed were hedonic and hedonic quality sensory properties for the attributes of color, aroma, texture, and taste of nuggets. The data obtained were analyzed by the Friedman Test, followed by the Wilcoxon Rank Test to detect the differences between treatments. Treatment of up to 75% seaweed substitution (0, 25, 50, and 75%) decreases significantly ($p < 0.05$) the hedonic sensory acceptance of the snakehead fish nuggets for all attributes except the texture which shows an increase. Whereas, the treatment with substitution of seaweed in the narrow percentage of 0, 5, 10, 15, and 20% gave an expected result, which showed that there was no significant difference ($p > 0.05$) of the hedonic sensory response for the overall acceptance. Nevertheless, 15% of seaweed substitution provides the best hedonic sensory response for overall acceptance. These results indicate that 15% of seaweed (*Eucheuma cottonii*) substitution is recommended for use in the processing of snakehead fish nuggets.

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INTRODUCTION

Snakehead fish (*Channa striata*) is known as freshwater fish found in South East Asia with the local Indonesian name of gabus or haruan (Listyanto and Andriyanto 2009, Duong et al. 2019). The fish is harvested from a natural environment like tides, lakes, streams, rivers, and wet rice plantations. These snakehead fish are still difficult to culture because of the high mortality in the larvae stage (Listyanto and Andriyanto 2009, Bijaksana 2012, Hidayatullah et al. 2015). Functional properties of the snakehead fish are reported for helping the process of healing burns and wounds after surgery (Rahayu et al. 2016). Striatin is the albumin free bioactive protein fraction isolated from snakehead fish (*Channa striata*). However, it is responsible for accelerating wound healing and serum albumin level recovery (Rahayu et al. 2016). Intake of snakehead fish albumin was reported to heal the wound (Fitriyani and Deviarni 2013, Putri and Agustina 2016) and increased albumin and creatinine (Sulistiyowati et al. 2008) and regenerate pancreas cells (Aisyatussoffi and Abdulgani 2013). Protein and albumin content of the snakehead fish meat is about 20 g and 63-107 mg per 100 g, respectively (Chasanah et al. 2015).

Because of the functional properties of the snakehead fish meat, creating a processed fish product from the snakehead fish will provide fish-based functional food. Cracker (Yuliani et al. 2018) and nuggets (Yulianti and Mutia 2018) are two types of favorite processed fish products. Nuggets are a processed fish product using fish meat minced or surimi at a minimum of 30%, mix with flour and other materials with binding flour (breadcrumbs), and coated with batter mix (Badan Standardisasi Nasional 2013). Like other freshwater fish, snakehead fish meat is very soft. It needs filling substances to have better performance, especially the texture.

Eucheuma cottonii is one type of a red seaweed, which belongs to carrageenanophytes seaweed (Hoffmann et al. 1995) that often used as the filling substance for food product like a wet noodle (Lubis et al. 2013), and nugget (Haryanto 2014, Astuti and Sugiarso 2015, Masita and Sukesu 2015, Aditomo et al. 2017). *E. cottonii* is easily found in East Kalimantan (Candra et al. 2011), so it is crucial to increase the economic value by promoting its using diversity. The use of seaweed will enrich the food product by fiber (Astawan et al. 2005), composed of carrageenan and cellulose (Hoffmann et al. 1995), which is very important for the intestine health and digestion system. The *E. cottonii* was also reported having anti-inflammation (Abu Bakar et al. 2015) and anti-tumor activity (Shamsabadi et al. 2013, Sakthivel and Devi 2019).

Masita and Sukesu (2015) showed that the addition of 15% of *E. denticulatum*, a type of red seaweed, increased the texture quality of snakehead fish nugget, however, until now there is no report on the use of *E. cottonii* as filler in fish nugget produce. This report describes the sensory acceptance of snakehead fish nugget following substitution other red seaweed, i.e., *E. cottonii*. The optimum substitution of the *E. cottonii* on the sensory acceptance was determined.

METHODS

Materials

Snakehead fish in medium-size and dried *E. cottonii* (EC) as bought from a traditional market, while other materials like salt, wheat flour, egg, garlic, onion, shallot, pepper, breadcrumbs, and vegetable oil were obtained from mini-market in Samarinda. H_2SO_4 , NaOH, $Na_2S_2O_3$, HCl, K_2SO_4 , phenolphthalein, ethanol absolute, and petroleum ether were provided by Sigma.

Experimental Design and Data Analysis

In this research, the optimal substitution of EC was determined. This research was conducted in two steps, i.e., 0-75% and 0-20% substitution of EC. Single-factor (substitution of EC) experiment was arranged in Completely Randomized Design, and each treatment was replicated by four times. Each sample was prepared in 100 g mixture of snakehead fish meat and EC with substitution of 0, 25, 50, and 75 g for the first step of experiment and continued by the second experiment by using EC substitution of 0, 5, 10, 15 and 20%. Sensory hedonic and quality hedonic responses for color, aroma, texture, and taste were determined. Data were analyzed by Friedman test continued by Wilcoxon Sign Rank test for the post hoc test.

Procedure

Preparation of fish meat puree

Fresh snakehead fish was weeded to separate the mucus, scales, head, tail, and fish droppings then washed again using running water. The skin and bone were then removed, and the white meat was added by lime juice to remove the fishy smell. The white meat was then washed once again, then drained. The fish meat puree was prepared by minced the meat using blender by added 10 % (w/w) ice cubes.

Preparation of seaweed puree

Dried seaweed was cleaned using flowing water then soaked in the water for two days to refresh the seaweed, while the water changed each at 12 h. The wet seaweed was washed using flowing water once again, then cut to small pieces. The seaweed puree was then prepared by grinding using a blender.

Nugget producing

The nugget producing was started by mixing the materials followed by several steps, i.e., steamed, cooled, molded, dipped in

the batter mix and rolled in breadcrumbs, and fried.

Mixing and steaming

Fish meat and seaweed puree of 100 g were mixed then added by 3 g salt, 30 g wheat flour, 10 g egg, and the rest ground ingredients, i.e., 2 g garlic, 3 g shallot, and 0.25 g pepper. The mixture was added by 20 mL of fish broth then ground until a homogenized mixture was attained, then steam for 30 min. The fish broth was prepared by boiling 100 g in 100 mL of water.

Cooling, molding, and breadcrumbs rolling

The dough was cooled in room temperature for 15 min until mild hard then molded in the form nugget in size of 2 x 3 x 1 cm. The nuggets were dipped in batter mix (shaken egg) then rolled in breadcrumbs.

Frying

Nuggets were fried for two minutes in hot oil until the golden brown color, and then the rest oil was drained.

Sensory test

The hedonic and quality hedonic sensory test was performed by 25 semi-trained panelists (students who have passed in Sensory Test lecture). The panelists were directed to the test procedure prior to taking the test. A five scores level was used in the sensory test.

Proximate analysis

Proximate analysis, including moisture, fat, protein, ash, and carbohydrate content (Sudarmadji et al. 2010), was applied for the nuggets provided by treatment showing the best hedonic sensory test for overall acceptance.

RESULT AND DISCUSSION

The hedonic sensory response of snakehead fish nugget (SFN) was affected

significantly ($p < 0.05$) by the *E. cottonii* (EC) substitution up to 75%. The higher the EC substitution, the lower the hedonic sensory response of SFN except for texture that showed an opposite trend. Higher EC substitution increased the texture score (Table 1) related to the increased sensory acceptance of texture. The hedonic sensory response median for color, aroma taste, and overall acceptability decreased from 4 (like) at control (0% of EC substitution) to 3 (rather like) at 75% of EC substitution. On the other hand, the hedonic sensory response for texture increased from 3 (rather like) to 4 (like). The trend of the decreasing of the hedonic sensory response for color, aroma, taste, and overall acceptability and the increase for texture, as well as the difference of quality hedonic sensory score between the level of seaweed substitution level as mean rank was shown in Figure 1.

A broad range substitution of cellulosic substance in nuggets showed a similar level of hedonic sensory response of SFN in this research, except the hedonic sensory response for texture. Substitution of banana corm puree at 25-75% gave a relatively same (not significantly different) level on the hedonic sensory response, i.e., rather like, for color, aroma, texture, and taste of skipjack fish (*Katsuwonus pelamis* L.) nugget (Pade 2018). The decreased sensory hedonic response of snakehead fish nugget substituted by straw mushroom (*Volvariella volvaceae*) in a broad range of 30-100% was also reported (Prastia et al. 2016). However, the use of bamboo shoots as other cellulose food in catfish nugget showed the opposite result. The substitution of bamboo shoots up to 30% increased the hedonic sensory for the overall acceptance of the catfish nugget (Silaban et al. 2017). The cellulose type used as the filler or substituent may be responsible for the different performances of fish nuggets.

Table 1. Effect of red seaweed substitution (*E. cottonii*) up to 75% on the sensory response of snakehead fish nugget

| Attribute | Substitution of the red seaweed (%) | | | | <i>p</i> * |
|------------------------|-------------------------------------|-------|--------|-------|------------|
| | 0 | 25 | 50 | 75 | |
| <i>Hedonic</i> | | | | | |
| Color | 4.0 c | 4.0 b | 3.0 a | 3.0 a | 0.0005 |
| Aroma | 4.0 c | 4.0 b | 3.0 a | 3.0 a | 0.0005 |
| Texture | 3.0 a | 3.0 a | 4.0 b | 4.0 c | 0.0005 |
| Taste | 4.0 c | 4.0 b | 3.0 a | 3.0 a | 0.0005 |
| Overall acceptance† | 4.0 c | 4.0 b | 3.0 a | 3.0 a | 0.0005 |
| <i>Hedonic quality</i> | | | | | |
| Color | 4.0 d | 4.0 c | 3.0 b | 3.0 a | 0.0005 |
| Aroma | 4.0 c | 4.0 b | 3.0 ab | 3.0 a | 0.0005 |
| Texture | 3.0 a | 3.0 b | 4.0 c | 4.0 d | 0.0005 |
| Taste | 4.0 c | 4.0 b | 3.0 b | 2.5 a | 0.0005 |

Note: The results were expressed as median from 100 data derived from the 4 replications assessed by 25 semi-trained panelists., except 400 data for overall acceptance derived from all attributes (color, aroma, texture, and taste). The data were analyzed by the Friedman test (*). Data within the same row, followed by a different letter, were significantly different (Wilcoxon Sign Rank Test, $p < 0.05$). The formula is based on 100 g of mixing of meat fish and seaweed. Hedonic sensory scale 1-5 for *very dislike* to *liking very much*. Hedonic quality sensory scale 1-5 for **color** (brownies yellow, yellowish-white, mild yellow, yellow, golden yellow.), **aroma** (very unscented of fish, not scented of fish, rather scented of fish, scented of fish, very scented of fish), **texture** (very chewy, chewy, rather chewy, rather soft, soft), **taste** (very tasteless of fish, tasteless of fish, rather tasted of fish, fish tasted, very tasted of fish).

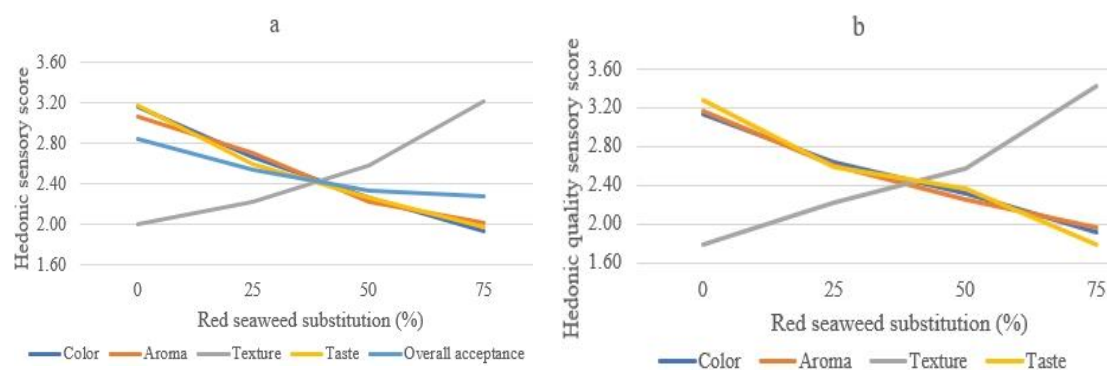


Figure 1. Changing trend of hedonic and quality hedonic responses of snakehead fish nugget with red seaweed (*Eucheuma cottonii*) substitution up to 75%. The data were presented as mean rank. The sensory scale is referred to as note in Table 1. Hedonic sensory response (a), hedonic quality sensory response.

The data provided by the first experiment show that the broad range of seaweed substitution (0-75%) is the main cause of the decreasing response of the hedonic sensory. At the first level of treatment (25% of EC substitution), a significant decrease of the hedonic sensory response was already determined, then followed by a higher level of substitution. The use of carrageenanophytes food source may use in a narrow range, with a maximum of about 20%.

Then a narrow range of seaweed substitution, 0-20%, was experimented. The results showed that the hedonic sensory response for color, aroma, and taste was not significantly affected by up to 20% of the EC

substitution, except the texture in which it showed a significant increase (Table 2.). The trend of sensory response change caused by up to 20% of EC substitution is presented in Figure 2 as means of rank.

This finding adds the information that substitution or addition of cellulosic or protein as water content binder or filler material in a narrow range could be applied in fish nuggets produce. It significantly affected the nugget produce performance. Some reports even showed that the use of such water content or filler material in a small percentage gave a better performance. The 15% of EC substitution is recommended in snakehead fish nugget produce.

Table 2. Effect of red seaweed (*E. cottonii*) substitution up to 20% on the sensory response of snakehead fish nuggets

| Attribute | Substitution of the red seaweed (%) | | | | | <i>p</i> * |
|------------------------|-------------------------------------|--------|--------|--------|--------|------------|
| | 0 | 5 | 10 | 15 | 20 | |
| <i>Hedonic</i> | | | | | | |
| Color | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 0.218 |
| Aroma | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 0.212 |
| Texture | 4.0 a | 4.0 a | 4.0 ab | 4.0 a | 4.0 b | 0.046 |
| Taste | 4.0 ab | 4.0 ab | 4.0 a | 4.0 b | 4.0 a | 0.021 |
| Overall acceptance ‡ | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 0.249 |
| <i>Hedonic quality</i> | | | | | | |
| Color | 3.0 a | 4.0 b | 4.0 b | 4.0 ab | 4.0 b | 0.018 |
| Aroma | 4.0 | 3.0 | 3.0 | 4.0 | 3.0 | 0.732 |
| Texture | 4.0 b | 4.0 a | 4.0 ab | 4.0 ab | 4.0 ab | 0.009 |
| Taste | 4.0 b | 3.0 a | 3.0 a | 4.0 b | 3.0 a | 0.0005 |

Note: same as the note in Table 1.

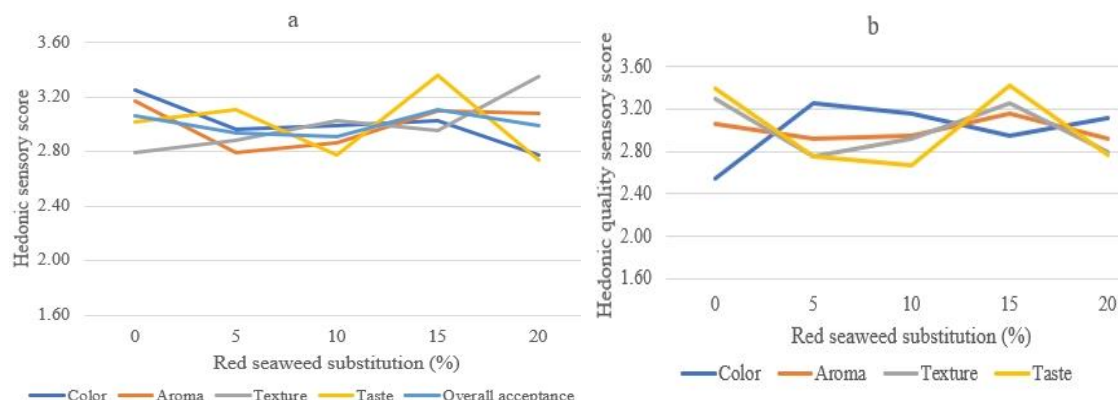


Figure 2. Changing trend of hedonic and quality hedonic responses of snakehead fish nugget with red seaweed (*Eucheuma cottonii*) substitution up to 20%. The data were presented as mean rank. The sensory scale is referred to the note in Table 1. Hedonic sensory response (a), hedonic quality sensory response (b).

The chemical properties of the 15% of EC substituted un-fried snakehead fish nuggets (taken from three replications) were 56.76 ± 2.44 , 12.20 ± 0.44 , 2.75 ± 0.35 , 25.18 ± 0.93 and $2.10 \pm 0.54\%$ for water content, protein, fat, carbohydrate, and ash, respectively.

The use of 10% of soybean flour (Ofrianti and Wati 2013) and 20% of red seaweed (*E. denticulatum*) (Masita and Sukesu 2015) were shown better performance in snakehead fish nugget compare to the nugget without the filler addition (control). The use of 15% of cowpea also showed the best of tilapia fish nugget performance than the control. The

CONCLUSION

Eucheuma cottonii (EC) is a potential filler in snakehead fish nugget produce. The 15-20% of EC substitution is recommended for an acceptable product. The 15% of EC substitution affects not significantly the sensory hedonic response for color, aroma, and texture, except taste that showed significantly better. At the same time, 20% of EC substitution showing significantly higher on the hedonic sensory response for texture compares to control (100% snakehead fish meat).

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