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The effect of *Eucheuma cottonii* flour addition to increase the elasticity of tilapia ekado

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Abstract
This study was conducted to determine the effect of adding flour Eucheuma cottonii which is able to increase the elasticity of tilapia and to find the most preferred tilapia ekado by panelists. The research was conducted at the Fishery Product Processing Laboratory, Faculty of Fisheries and Marine Sciences, Padjadjaran University from December 2019 to January 2020. The study was conducted with an experimental method consisting of four treatments of adding *E. cottonii* flour such as 0%, 1.5%, 2.5% and 3.5% with 20 semi-trained panelists as repeat examinations. The parameters observed were folding test, yield, elasticity test with Texture analyzer, hedonic test and proximate test. The results showed that ekado tilapia with the addition of E.cottonii as much as 2.5% of the weight of tilapia meat produced the best and most preferred product with a folding test value of 3.95 and a median of 4.0 (springy), a yield value of 1.19 %, and the elasticity value is 147.51 gForce. Based on the hedonic test, the appearance value was 6.7; aroma of 7.2; taste of 7.4 and texture of 7.9. Based on Bayes test obtained an alternative value of 7.46.

Keywords: bayes test, tilapia ekado, elasticity, hedonic, seaweed

1. Introduction
Eucheuma cottonii or also known as seaweed is a very abundant biological resource in Indonesian waters. Seaweed diversity in Indonesia is the largest compared to other countries. According to Hadiyantono *et al.* (2018)[3], Indonesia's total production of *E. cottonii* reached 16 million tons in 2018 but as much as 80% of the total production was exported to various countries without prior processing. One way to reduce the export of *E. cottonii* is by developing technology for processing fishery products such as by diversify *E. cottonii* products. The development of products *E. cottonii* can be done by domestic industries either into semi-finished products or finished or processed products. Processing can increase the value of the product and can increase the level of community preference so that consumption of *E. cottonii* can increase. One form of processing of *E. cottonii* that can be directly utilized by the community is *E. cottonii* flour. *E. cottonii* flour is a semi-finished product made using *E. cottonii* which is dried and then ground to a fine grain. *E. cottonii* flour can be used to improve the quality of textures in fishery products such as fishjelly products. One fishjelly product that can be added with *E. cottonii* flour is fish ekado. Ekado is one of the fishjelly products originating from Japan. Ekado has the characteristics of a form that resembles a bag because ekado is wrapped in tofu skin, dumpling skin or spring roll skin and tied the ends. The contents of the ekado are made from processed fish and must have a chewy and soft texture. However, ekado made in the home industry generally does not have a chewy texture. According to Prabowo (2011)[12], *E. cottonii* flour can be used to improve the gel texture and suppleness of the product. *E. cottonii* flour has carrageenan content which can increase the binding power of water, improve the strength of the final product and protect the product from the freezing process. This research was carried out with the aim to determine the percentage of addition of *E. cottonii* flour to the best tilapia ekado by the panelists and provide the best texture.

2. Research Methods
2.1 Tools and Materials
Tools used in this study include: scales, *food processors*, mortars, knives, cutting boards, pans, fryers, stoves, spoons and filters. Materials used in this study include: *E. cottonii* flour, tilapia meat, eggs, tapioca flour, garlic, onions, salt, sugar, pepper, lunpia skin, ice and cooking oil.

2.2 Research Methods
This research was conducted with an experimental method. This research was conducted with four treatments including 0%; 1.5%; 2.5% and 3.5% addition of *E. cottonii* flour from the weight of tilapia. The parameters observed were: folding test, yield test, elasticity test, preference test (hedonic), Bayes test and Proximate test.

2.3 Making Tilapia Ekado
Making tilapia ekado based on Indriasari (2014) [7]with modifications. First, the Tilapia Filet is mashed with a food processor and given salt. The subtle meat then given tapioca flour, salt, sugar, egg whites, pepper and onions and then homogenized with a food processor. The mixture is added with *E. cottonii* flour according to the treatment and then homogeneous again. The dough is wrapped in spring roll skin. Next, the ekado is steamed for 20 minutes at 90ºC. The cooked ekado is fried in oil at 170ºC for 3 minutes or until its golden brown.

2.4 Analysis
Yield, elasticity and proximate were analyzed descriptively. The folding test and the hedonic test were analyzed using the *Friedman* test with the Chi-square test and continued with the multiple linear test. The test used 20 semi-trained panelists as a test. Decision making is done using the Bayes test. Proximate tests were also carried out as chemical tests to

determine the nutrient content in control ekado and ekado with the best results.

3. Results and Discussion

3.1 Folding Test

Test Folding test is one way to find out the elasticity of a product. The folding test can be directly related to the gel quality or elasticity of the fish ekado (Nurwin *et al.* 2019) [11]. The results of observations from the folding test are presented in Table 1 below.

Table 1: Average Folding Test Value of Tilapia Ekado

Treatment (%)	Median	Average
0	2	1.95^a
1.5	3	2.85^a
2.5	4	3.95^b
3,5	3	$2,5^a$

Note: Numbers followed by the same letters show results that are not significantly different at the 5% test level

The highest average fold test value of tilapia fish is found in the treatment of 2.5% with a value of 3.95 with a median of 4 (Chewy) while the lowest average value is in the treatment of 0% or control with a value of 1.95 with a median of 2 (Less Chewy). The addition of *E. cottonii* flour 2.5% gives the best folding test results because *E. cottonii* helps gel formation and binds water to ekado so that the elasticity of ekado increases. Ekado with the addition of *E. cottonii* flour as much as 3.5% tends to give less elastic results because the amount of water used in making the dough is the same so that not all parts of the *E. cottonii* flour bind water and cause ekado dough with the addition of *E. cottonii* flour as much as 3,5% become drier or the
water content is not as much as other treatments. This is in accordance with the statement of Prabowo (2011)[12] *E. cottonii* can help improve water binding, viscosity of the product and gelling and *E. cottonii* containing 65% carrageenan thats make a small concentrations of *E. cottonii* flour has been able to give the effect of a strong gel formation

3.2 Yield

Yields can affect the economic value of a product. The higher the yield value produced, the higher the output and the economic value of the product Tamahaeng (2017)[13]. The yield values obtained from tilapia can be seen in the following Table 2.

Table 2: Yield of Ekado Tilapia

Treatment (%)	Yield of Ekado Tilapia (%)
0	1.03
1.5	1.12
2.5	1.19
3.5	1.21

Based on observations, it can be seen that the yield of the Ekado Tilapia continues to increase with increasing *E. cottonii* flour. The highest yield of tilapia ekado is ekado with the addition of *E. cottonii* flour as much as 3.5% with a yield value of 1.21%. While the lowest yield is ekado with a treatment of 0% with a yield value of 1.03%. These results are in line with the results of Prabowo's research (2011) [12] where he added *E. cottonii* by 2.5%, 5% and7.5% to catfish meatballs and the yield from the catfish meatballs continues to increase with increasing use of *E. cottonii*. The yield of tilapia ekado continues to increase with the addition of *E. cottonii* flour used because *E. cottonii* contains *kappa carrageenan* which can form a gel and bind water so that the weight of the cooked tilapia ekado is increased. The statement is in accordance with Prabowo's (2011) [12] statement which states that carrageenan is hydrophilic which is able to bind water and can form a strong gel, carrageenan is able to optimize product characteristics and costs, carrageenan is also able to increase yield in a product.

3.3. Elasticity Test

Elasticity is the rate of deformation to its original shape after being given a force to change the shape of the product. The purpose of measuring elasticity is to determine the level of elasticity in a material or product. Measurement of elasticity is carried out using a Texture analyzer (Prabowo 2011)[12]. The average elasticity of tilapia as measured by the Texture Analyzer can be seen in Table 3 below.

Table 3: Elastic Value of Tilapia Ekado

Treatment (%)	Elasticity Value (gForce)
0	26.47
1.5	74.88
2.5	147.51
3.5	93.22

The elastic value of tilapia ekado continues to increase starting from the control treatment to 2.5% treatment and then decreased at 3.5% treatment. The control treatment is the treatment that has the lowest elasticity value that is equal to 26.47 gForce. Tilapia Ekado with the highest elasticity value was found in tilapia with the addition of *E. cottonii* flour by 2.5% with an elasticity value of 147.51 gForce. Tilapia ekado with the addition of *E. cottonii* flour by 3.5% decreased its elasticity value when compared to 2.5% treatment with an elasticity value at 3.5% treatment amounted to 93.22 gForce. Based on the test results it can be seen that the use of *E. cottonii* flour can increase the elasticity of tilapia ekado to a certain point. Increased elasticity of tilapia ekado caused by gels that are formed from carrageenan contained in *E. cottonii* flour. Carrageenan in *E. cottonii* is able to form a strong gel after the product is cooked so that it can increase the elasticity of tilapia ekado. The addition of *E. cottonii* flour after exceeding a certain point will reduce its elasticity because the gel formed will become denser. A gel that is too dense can make the ekado become hard and break easily easily so that the ekado becomes less elastic.

3.4 Hedonic Test

1. Appearance

Appearance is one of the first characteristics that are valued by consumers of a product. Although appearance does not determine the level of sensory absolutely, but the appearance also affects consumer acceptance. According to Nurwin *et al.* (2019)[11]the first impression felt by consumers when they see a product is usually through the appearance or appearance of the product and in general consumers prefer products that have an attractive appearance. The average value of the appearance assessment of tilapia ekado is presented in Table 4.

Table 4: Average appearance of Tilapia Ekado

Treatment (%)	Median	Average
0	5	5.7^a
1.5	7	6.3^a
2.5	7	6.7^a
3.5	7	6.3^a

Note: Numbers followed by the same letters show results that are not significantly different at the 5% test level

Based on the test results, it can be seen that each treatment does not show a significant difference and the results of statistical tests state that there is no real difference between each treatment. The lowest average value was found in tilapia without the addition of *E. cottonii* flour with an average value of 5.3 while the highest was in the treatment of adding *E. cottonii* flour by 2.5% with an average value of 6.7. The treatment of adding *E. cottonii* flour as much as 1.5% and 3.5% has the same average value of 6.3. Tilapia Ekado at 0% treatment appears white. Tilapia Ekado in the treatment of adding *E. cottonii* flour by 1.5% brownish gray and in the treatment of 2.5% the color is slightly darker than the 1.5% treatment. The treatment of adding *E. cottonii* flour as much as 3.5% has the darkest color compared to other treatments. According to Prabowo (2011) [12]the use of seaweed in food can cause a Maillard reaction. Maillard reaction is a reaction between carbohydrates and proteins that can change the color of the ekado to be brown or cream. This study uses tapioca flour with the same amount each treatment and the addition of E.cottonii between treatments is not large so the changes that occur are not significant between treatments.

2. Aroma

Aroma is also called remote tasting using the sense of smell. Humans can recognize the delicious food that has not been seen only by smelling the aroma of food from a distance (Nurwin *et al.* 2019)[11]. The food industry considers the aroma test is one of the important tests because it can quickly provide the results of the assessment of whether or not a product is liked. The average value of the aroma assessment of ekado tilapia is presented in Table 5.

Table 5: Average Aroma of Ekado Tilapia

Treatment (%)	Median	Average
0	7	6.3^a
1.5	7	6.7^a
2.5	7	7.2^a
3.5	7	6.3^a

Note: Numbers followed by the same letters show results that are not significantly different at the 5% test level

Based on the test results, it can be seen that the panelists liked all treatments based on their aroma. The most preferred tilapia is the tilapia with 2.5% treatment with an average value of 7.2 and the lowest is 0% and 3.5% treatment with an average of 6.3. The aroma of ekado tilapia does not differ in each treatment because all the ingredients used are in the same condition that is in a fresh state. *E. cottonii* flour used has a neutral aroma so that its use does not affect the aroma characteristics of the tilapia. Agusman *et al.* (2014)[1]states that *E. cottonii* flour has a neutral aroma so it does not affect the aroma of the product produced.

3. Taste

Taste is an important parameter because it determines consumer acceptance of food products. Taste is influenced by several factors, chemical compounds, their concentration and interactions with other components (Nurwin *et al.* 2019)[1]. According to Machmud *et al.*(2012)[8], amino acids are one of the components forming odors and flavors. Amino acids found in fish protein in food technology can affect sweetness, taste, even bitter. The average value of the flavor assessment of tilapia tilapia is presented in Table 6.

Table 6: Average Taste of Tilapia Ekado

Treatment (%)	Median	Average
0	5	5.6^a
1.5	7	6.1^{ab}
2.5	8	7.4^b
3,5	7	6.0^a

Note: Numbers followed by the same letters show results that are not significantly different at the 5% test level

Based on the test results, it can be seen that panelists favor ekado with the addition of *E. cottonii* flour. The 1.5% to 2.5% treatment was not significantly different but significantly different from the treatment of 0% and 3.5%. The 2.5% treatment is the most preferred treatment by panelists with an average value of 7.4 while the least preferred treatment by panelists is the 0% treatment with an average value of 5.6. Tilapia With the addition of *E. cottonii* flour, ekado with 3.5% treatment decreased on average because in the treatment the ekado became tasteless compared to other treatments. The tastelessness of tilapia ekado with the addition of *E. cottonii* flour as much as 3.5% due to the use of *E. cottonii* flour more than other treatments. *E. cottonii* has a bland taste because the content of protein, carbohydrates and fats in *E. cottonii* is very low. The results of this study are consistent with the statement of Agusman *et al.* (2014)[1] which states that the addition of seaweed flour as much as 7% produces less tasty rice with a bland taste that panelists dislike.

4. Texture

Texture is sensing that can be felt through skin touch. There are many types of textures in foods including smooth or not, liquid or solid, hard or soft and dry or wet. Texture is important for soft or crunchy foods. The most frequently cited characteristics are violence, cohesiveness and water content (Hartati 2011)[5]. The average value of the texture assessment of tilapia ekado is presented in Table 7.

Table 7: Average Texture of Tilapia Ekado

Treatment (%)	Median	Average
0	5	5.6^a
1.5	7	6.4^{ab}
2.5	9	7.9^b
3.5	5	5.9^a

Note: Numbers followed by the same letters show results that are not significantly different at the 5% test level

The results of statistical tests using the Friedman method show that there are significant differences in the treatment of 2.5% to the treatment of 0% and 3.5% but not significantly different from the treatment of 1.5%. Based on the results, it can be seen that the best treatment is the treatment of adding *E. cottonii* flour as much as 2.5% of the weight of fish with an average value of 7.9 and the median value on a scale of 9

(very like). The control treatment or without the addition of E.cottonii flour and the addition of *E. cottonii* flour by 3.5% is the lowest treatment but still at a neutral level (5). The 0% tilapia has a smooth, runny and soft texture so the ekado is not elastic and break easily. The use of 1.5% *E. cottonii* flour makes the Tilapia Ekado texture more elastic, still smooth and slightly runny because *E. cottonii* flour absorbs water that cannot be bound by tapioca flour and tilapia meat. The treatment of adding *E. cottonii* flour as much as 2.5% produces the best texture because *E. cottonii* flour absorbs water and produces more gel than the previous two treatments so it has a more elastic texture. The 3.5% treatment tends to have a less elastic, hard, dry and coarser texture compared to other treatments because the amount of *E. cottonii* flour is excessive and causes less water content than other treatments so that the gel formed is not as good as the 2.5% treatment. The content of carrageenan in *E. cottonii* flour is hydrophilic and able to absorb water so that it can affect the viscosity of the product. *E. cottonii* is able to form a gel derived from carrageenan kappa content in it. (Diharmi 2016)[2].

3.5 Bayes Test

Bayes method is a technique that can be used to analyze in making the best decision of a number of alternatives or treatments by considering the weighting of criteria and median values (Marimin and Slamet 2010)[10].

The results of calculating the criteria weights and alternative values using the Bayes method are presented in Table 8 below.

Table 8: Decision of Tilapia Ekado Assessment with Bayes Method

Treatment%	Appearance	Aroma	Flavor	Texture	Alternative Value	Rank
0	5,7	6,3	5,6	5,6	5,70	0,23
1,5	6,3	6,7	6,1	6,4	6,30	0,25
2,5	6,7	7,4	7,4	7,9	7,46	0,29
3,5	6,3	6,3	6,0	5,9	6,04	0,24
Weight Criteria	0.11	0.13	0.42	0.34	25.51	1

Based on the calculation of the weight criteria of appearance, aroma, taste and texture of tilapia tilapia, it is found that taste is the most important criteria that determines the final decision of panelists in choosing tilapia ekado products. Based on testing by Bayes method, it can be seen that the treatment of adding *E. cottonii* flour as much as 2.5% of the weight of the meat is the treatment that has the highest alternative value of 7.36. The treatment of adding *E. cottonii* flour as much as 1.5% is the second best treatment with an alternative value of 6.37 and the lowest treatment is in the control treatment with an alternative value of 5.80. Based on these calculations, it can be said that the treatment of adding *E. cottonii* flour as much as 2.5% of the weight of the meat to the tilapia ekado is the best decision because the treatment is most preferred by panelists. These results are in accordance with the hypothesis because the results of hedonic testing also indicate that the treatment is the best treatment because most panelists prefer.

3.6 Proximate Test

Proximate analysis is a chemical test to determine the nutrient content contained in a food product. Proximate analysis has benefits as an assessment of the quality and standard of food substances that should be contained therein. The results of proximate tests conducted on tilapia ekado can be seen in Table 9.

Table 9: Chemical Content of Ekado Tilapia

Parameter	Addition of *E. cottonii* flour	
	0%	2.5%
Protein content (%)	12.32	14.03
Ash content (%)	1.97	1.92
Moisture content (%)	38.38	35, 59
Fat Levels (%)	13.34	13.72
Crude Fiber (%)	0.75	0.76
Carbohydrate Levels (%)	33.27	34.02

Based on the results of proximate testing on tilapia ekado, it can be seen that there is an increase in protein content in ekado tilapia added with *E. cottonii* flour compared with ekalo which was not given additional *E. cottonii* flour. Tilapia Ekado which was added with *E. cottonii* flour has a protein content of 14.03%. The increase in protein content is caused by the content contained in *E. cottonii*, one of which is protein by 5.62% based on tests conducted by Maharany *et al.* (2017)[9]. These results are reinforced by Hartati's statement (2011)[5] which states that the addition of *E. cottonii* can cause the protein content of the product to increase because there is protein derived from *E. cottonii*. The addition of *E. cottonii* flour did not provide a significant difference in ash content in tilapia ekado. Tilapia Ekado with the addition of *E. cottonii* flour tended to have less ash than the control tilapia ekado with a difference of 0.05%. Untreated tilapia tilapia had ash content of 1.97% while tilapia ekado with the addition of 2.5% *E. cottonii* flour had ash content of 1.92%. Ekado tilapia without the addition of *E. cottonii* flour has a greater water content than ekado tilapia with the addition of *E. cottonii* flour with a water content of 38.38 for control tilapia ekado and 35.59 for treatment tilapia ekado. These results show that the addition of *E. cottonii* flour has a major influence in reducing the water content found in tilapia. *E. cottonii* flour has a low water content so that when ekado is added *E. cottonii* flour the water in the dough is absorbed by *E. cottonii* flour thus reducing its water content. The statement is in accordance with the statement of Prabowo (2011)[12] which states that the carrageenan in *E. cottonii* is hydrophilic which is able to bind water and can form a strong gel and 65% of the content in *E. cottonii* is carrageenan. The addition of *E. cottonii* flour affects the fat content contained in tilapia ekado. Tilapia ekado with the addition of *E. cottonii* flour has a fat content of 13.72% and tilapia ekado which is not added *E. cottonii* flour has a fat content of 13.34%. These results were obtained because *E. cottonii* has a fat content of 2.32% so ekado with the addition of *E. cottonii* flour has a higher fat content. This is in accordance with the statement of Hartati (2011)[5]which states that *E. cottonii* can increase the fat content in a product. The fiber content of ekado tilapia with the addition of *E. cottonii* flour is greater than that of

ekado tilapia without the addition of *E. cottonii* flour. Tilapia Ekado with the addition of *E. cottonii* flour has a fiber content of 0.756% while in ekado tilapia without *E. cottonii* flour only contained 0.752% fiber. The crude fiber content in ekado with the addition of *E. cottonii* flour is greater than ekado without the addition of *E. cottonii* flour because there is a crude fiber content in *E. cottonii* as much as 1.82% which causes more and more additions of *E. cottonii* the greater the fiber content. This statement is supported by the statement of (Hidayat *et al*. 2014)[6] which states that the crude fiber content is increasing with the increasing number of seaweed. The addition of *E. cottonii* flour has an effect on the carbohydrate content of tilapia. Tilapia ekado with the addition of *E. cottonii* flour has a carbohydrate content of 34.02% while ekado tilapia without the addition of *E. cottonii* flour has a carbohydrate content of 33.27%. Carbohydrates in ekado added with *E. cottonii* flour increase because in *E. cottonii* there are carbohydrates as much as 0.11% so that the more use of *E. cottonii*, the higher the carbohydrate content.

4. Conclusion

Based on the results of this study, it can be concluded that tilapia ekado treatment with the addition of flour of *E. cottonii* 2.5% produces the best and most preferred product for panelists. Tilapia Ekado at 2.5% treatment had a folding test result of 3.95 with a median of 4.0 (springy), a yield value of 1.19% and an elasticity value of 147.51 gForce. Based on the hedonic test, the appearance value was 6.7; aroma value of 7.2; taste value of 7.4; texture value of 7.9 and based on the Bayes test obtained an alternative value of 7.46

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