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THE POTENTIAL OF EDIBLE COATING OF KAPPA CARRAGEENAAN IN REDUCING OIL IN FRIED FISH CAKE

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ABSTRACT

High oil content in serving fish cake using a deep fry, can cause bad effects to the health. Addition of the edible coating kappa carrageenan is an effort to reduce the excessive oil content. This is related to the function of the edible coating kappa carrageenan, as a barrier to the evaporation of water in the material and the barrier to the entry of oil during frying process. This study aimed to determine the effect of the edible coating of kappa karaginan as an oil reduction on the fried fish cake and optimum concentration of edible coating on the fried fish cake. The method of the study was an experimental study with descriptive statistical analysis. The results showed that the highest water content was found in the fish cake with the addition of edible coating of kappa carrageenan with a concentration of 3% as much as 46.16%. The highest ash content was found in fish cake with the addition of edible coating of kappa carrageenan with a concentration of 3% as much as 7.51%. Whereas, the lowest fat content was found in fish cake with the addition of 3% edible coating of kappa carrageenan was 4.72%. The highest fat content in fish cake without edible coating was 9.37%. In conlusion, the administration of the edible coating of kappa carrageenan with a concentration of 1% was the best treatment for reducing oil in fried fish cake.

Keywords: Edible coating, Kappa carrageenan, Fish-cake, Deep fry.

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1. INTRODUCTION

The potential of fisheries resources in Indonesia is very abundant. With the abundance of fishery products, it is needed with balanced harvesting when a species is exploited according to their productivity (Jacobsen, Gislason and Andersen 2013). One of the diversified products that is quite popular is fish cake. Indonesian fish cakes are known as *otak-otak*. Fish cake is processed using other products that contain salt-soluble proteins from certain fish meat (Hwang, Choi and Lee 2013). Fish cake is a processed product that has a high nutrient content. Fish cake is from raw material, namely salmon, narrow-barred Spanish mackerel and cod. In making fish cake, we need also some other ingredients. Fish cake or *otak-otak* requirements are regulated according to SNI 7757:2013, which has maximum water content of 60%, maximum ash content of 2%, maximum protein content of 5%, and maximum fat content of 16%.

The processing of fish cake is with the deep frying method. Deep frying is one way to cook food using large amounts of oil, repetitive and high temperature (Ghidurus, et al. 2010). Fried products generally contain high oil absorption due to the duratiom of food contact with cooking oil during the frying process. The deep frying process starts from inserting the ingredients into hot oil, thus making the surface temperature of food ingredients rise rapidly (Omer, et al. 2014). The temperature of the oil commonly used is 150-190^{0}C (Dunford 2006). The high oil absorption due to the deep frying process causes some negative effects in the body. The effects that often arise are cholesterol, high blood pressure and coronary heart disease (Albert and Mittal 2002). The quality of oil is very important because it has a major role on the oil-absorption in the product (Omer, et al. 2014). It can also be said that oil from any material will always absorb the product if it is served in a deep-frying manner. In addition, Mendonça, et al (2014) explained that although food fried in deep-frying method can be better and faster to be prepared, heating the oil at high temperatures can cause chemical, physical, and physical-chemical changes. The deep-frying process can produce toxic compounds, such as aldehydes, ketones, free radicals and so on.

The oil absorption is influenced by several factors, namely water content, material cavity, product geometry and time of frying used (Bouchon 2009). In addition, the oil absorption process occurs when the process of evaporation of water in the material during frying occurs. The cavity form in the material makes oil easily to absorb by the material. The length of the frying time affects the oil absorbed. The longer a material is fried, the more water evaporation process which makes the hollow form (Krokida et al. (2000) cited in Bouchon (2009)).

One effort to reduce the absorption of oil in food is by providing edible coating. Edible coating is a thin layer that forms on the surface of food to extend the shelf life of these food (Zambrano-Zaragoza, et al. 2018). In addition, edible coating is one way to maintain the quality of food at a fairly affordable cost. The hydrocolloid edible coating also has a function to prevent moisture and is less permeable to oxygen, making food more durable (Lacroix and C 2005). Edible coating is also a material that has the potential as a barrier for oil absorption during frying (Albert and Mittal 2002).

Edible coating components can be classified into three types, hydrocolloid, fat and composite (Varela and Fiszman 2011). One type of hydrocolloid that can be used is carrageenan. Carrageenan is a water-soluble polymer of linear chains of some galactant sulfates which has the potential to form thin layers (Skurtys, et al. 2011). In addition, hydrocolid can also be a barrier to fat and oil (Tavassoli, et al. 2015).

Carrageenan is a natural hydrophilic polymer with a linear chain as a part of galactant sulfate which has potential as a filmmaker (Skurtys, et al. 2011). Kappa carrageenan is generally obtained from seaweed (*Kappaphycus alvarezii*) which is known by the trade name of *Euchema denticulatum* (Rudolph 2000). The barrier properties of this kappa carrageenan edible coating keep the water in the material slightly out during frying. The use of edible coating is one solution to be a barrier to oil absorption during the frying process (Albert and Mittal 2002). Kappa carrageenan gel will coat the ingredients at the time of frying. The layer of edible coating of kappa carrageenan serves as a barrier from the evaporation process during frying. The evaporation process which is reduced or the release process of water from a reduced material will make the oil entering or absorbing less. This inhibit the fried material to absorbs the oil because of the edible coating. This study aimed to determine the effect of edible coating as a reducing oil on fried fish cake and optimum concentration of edible coating on fried fish cake.

2. MATERIAL AND METHODS

2.1. Preparation of Edible Coating

This study is conducted in April 2017 located in Dry Laboratory of Faculty of Fisheries and Marine, Universitas Airlangga, Surabaya, Indonesia. There were several experiments in this study, such as ash content experiment, water content experiment, protein content experiment, and fat content experiment.

2.2 Material and Tools

The tools used in this study were baking pan, knife, basins, tissue, porcelain cup, pan, deep fry pan, claws, tray, 500 ml Beaker glass, furnace, thermometer, oven, magnetic stirer, gloves, glass spatula, soxhlet, kjeldahl bottles, water bath, spoons, crush tank, static pole, mortal and analytical scales. The materials used in this study were “champ” brand fish cake, cooking oil, refined kappa carrageenan flour produced by CV. Nura Jaya and distilled water.

2.3 Experimental Diets

This study was an experimental study with a completely randomized design (CRD) trial design. This study consisted of four treatments and four replications so that 20 research units were obtained. The treatments given are as follows: Treatment P0: fish cake without administration of edible coating; Treatment P1: fish cake with the administration of edible coating of 1% kappa carrageenan. Treatment P2: fish cake with the administration of edible coating of 2% kappa carrageenan. Treatment P3: fish cake with the administration of edible coating of 3% kappa carrageenan.

There are three variables in this study, namely independent variables, dependent variables and control variables. The independent variable in the study was kappa carrageenan. The dependent variables in the study were ash content, water content, proteindan content and fat content in fried fish cake. Whereas, the control variables in the study were fish cake with brand of “Champ”, fish cake size, type of kappa carrageenan, cooking oil, tools (accuracy of the tool), frying temperature (170^{o}C), and frying time (1.5 minutes).

2.4 Experimental Procedures

There are several experimental procedures in this research. The first is the preparation of materials and tools. The next is material preparation, such as fish cake, fried oil, kappa carrageenan, and aquades. The following procedure is the process of making edible coating. It is followed by the application of edible coating from kappa carrageenan on fried fish cake. The last step is the deep fry process. The experiments after deep fry process are experiment on the water content, ash content, protein content, and fat content. Organoleptic experiment is also important in this research in order to have better understanding in the quality of the experimental product.

2.5 Statistical Analysis

The data of the application edible coating cappa carrageenan were analyzed by using *Analysis of Variance* (ANOVA) in order to know the oil content as the effect of edible coating on the fried fish cake. If there is an effect on the result of the study, the research will be followed by Duncan's Multiple Distance Test.

3. RESULTS AND DISCUSSIONS

There were three initial calculations that go through the repetition process as many as five times with Treatments P0, P1, P2, and P3. The calculation was the calculation of water content, ash content, and fat content in fried fish cake. The results of the three calculations are shown in Table 1.

Table 1 Results of Calculation of Water Content, Ash Content, and Fat Content in Fried Fish Cake

Water Content						
Treatments	Repetition					Mean ± SD
	1	2	3	4	5	
P0 (0%)	32.28	34.87	35.07	36.66	40.22	35.82 ^{a} ±2.92
P1 (1%)	38.59	39.9	41.44	42.62	41.67	40.84 ^{b}±1.59
P2 (2%)	42.34	44.53	43.56	42.41	43.39	43.25 ^{bc}±0.91
P3 (3%)	40.92	50.89	45.55	44.81	48.64	46.16^{c}±3.81
Ash Content						
Treatments	Repetition					Mean ± SD
	1	2	3	4	5	
P0 (0%)	5.71	6.56	10.4	8.93	5.06	7.33^{a} ±2.26
P1 (1%)	2.45	9.8	10.97	7.23	6.04	7.30 ^{a}±3.35
P2 (2%)	6.71	10.64	10.73	4.03	4.7	7.36^{a}±3.19
P3 (3%)	5.22	6.43	8.57	6.29	11.03	7.51 ^{a}±2.31
Fat Content						
Treatments	Repetition					Mean
	1	2	3	4	5	
P0 (0%)	10.45	8.3	10.5	8.7	8.9	9.37^{a}±1.03
P1 (1%)	7.25	6.7	7.2	6.2	1.92	5.85^{b}±2.24
P2 (2%)	6.6	5.3	4.3	5.7	4.93	5.37 ^{b}±0.87
P3 (3%)	2.8	1.46	6.7	8.96	3.7	4.72^{b}±3.05

* Notation indicated by different superscript letters in the same column shows that the comparison between treatments has a significant difference (P<0.05).

Calculation of water content aimed to determine the content of water content in fish cake. The water content examination in fish cake was done after the frying process. Water content data in fish cake can be seen in Table 1. The results were variant analyzed that showed the P0 had a significantly different effect on water content in all treatments (P1, P2 and P3). The P1 had a significant effect on the moisture content in P0 and P3. The P2 showed results that were not significantly different from water content in P1 and P3.

The results of water content test in fish cake ranged from 35.82% to 46.162%. The frying process in fish cake used a temperature of 170°C. The results of the calculation of water content in fish cake without the treatment of the addition of edible coating of kappa carrageenan had the lowest moisture content of 35.82%. Whereas, fish cake with the addition of kappa carrageenan edible coating with a concentration of 3% had the highest water content of 46.162%. This is in accordance with Kokoszka and Lenart's (2007) study that edible coating in coating a product is determined by product specific requirements, one of which is water content. Changes in water content during production and storage also have big effect.

Ash content test in fish cake was done after the frying process. The purpose of the measurement of ash content was to find out the inorganic content in fried fish cake. Data on ash content based on treatment and replication can be seen from Table 1 The data analyzed using variance showed that the treatment of edible coating with various percentage concentrations (0%, 1%, 2% and 3%) of kappa carrageenan in all treatments was not significantly different from the levels of ash fried fish cake.

The value of ash in fish cake obtained ranged from 7.298% to 7.508%. The results of ash content in the treatment of fried fish cake without the addition of carrageenan kappa edible coating had the lowest ash content of 7.322%. Whereas, the ash content with the addition of edible coating of 3% carrageenan kappa produced the highest ash content of 7.508%.

The fat content test was done on fish cake after frying. The purpose of fat content test was to find out the fat content found in fried fish cake. Data on the results of fat content in each treatment and replication can be seen in Table1. The data analysis using variance showed that the addition of edible coating of kappa carrageenan in P0 had a significant effect on fat content in all treatments (P1, P2 and P3).

The protein test was aimed to determine the protein content of fish cake without the addition of edible coating of kappa carrageenan and by the addition of edible coating of kappa carrageenan. Protein content test was done on fish cake after the frying process. Protein test data showed the mean value of fish cake without the administration of edible coating of kappa carrageenan and with the addition of edible coating of kappa carrageenan ranged from 2.94% to 5.97%. The value of protein content in the treatment without the addition of kappa carrageenan edible coating was 2.94%. Whereas, protein levels in the treatment with edible coating were 1%, 2% and 3% carrageenan kappa at 5.15%, 5.63% and 5.97%.

Organoleptic test in fish cake included five parameters, which were color, texture, aroma, appearance and taste. Panelists chose scores on forms that can be seen in Appendix 2. Score that was worthy of being accepted by the panelists was at least 7. The results of the assessment of the mean scores of organoleptic test can be seen in Table 2.

Table 2. Assessment Results of Mean Scores of Organoleptic Test of Fried Fish Cake

Parameters	P0	P1	P2	P3
Colors	7.21	6.81	5.59	6.29
Texture	8.15	7.86	6.58	7.36
Aroma	7.04	7	6.92	6.71
Appearance	8.15	7.89	7.25	7.59
Taste	8.39	8.15	7.72	7.55

The assessment results of the mean scores of the organoleptic test at P0, P1, P2 and P3 for the color parameters obtained scores ranging from 5.59 to 7.21. The mean score of the organoleptic test included the category of score 7, which was brownish red. The brownish red color was caused by the mailard reaction during the frying process.

The assessment results of the mean scores of the organoleptic test for texture parameter obtained scores ranging from 6.58 to 8.15. The mean score in P0 and P1 were included in the category of score 9, which was springy, compact, and solid. Whereas, in P2 and P3 the mean scores were included in category 7, which was springy, compact and less dense. This is because the higher the concentration of edible coating of kappa carrageenan in fried fish cake causes the texture to be slightly soft.

The assessment results of the mean scores of the organoleptic test for aroma parameters in P0, P1, P2 and P3 ranged from 6.71 to 7.04. The mean scores of the organoleptic test were in the category of score 7, which was the smell of fish. The difference in the addition of concentrations of kappa carrageenan edible coating in fried fish cake had no effect on aroma.

The assessment results of the mean scores of the organoleptic test for the appearance parameter in P0, P1, P2 and P3 ranged from 7.25 to 8.15. The P0, P1 and P3 had mean scores included in the score category of 9. The P2 had a score of 7.25 which included in category of score 7, but the results only had difference of 0.34 with the P3 treatment. This is presumably because the difference in the addition of edible coating of kapa carrageenan had slightly effect on the thickness layer of fried fish cake so that the score of appearance parameter had no significant difference.

The results of the assessment of mean scores of the organoleptic test for taste parameters in P0, P1, P2 and P3 ranged from 7.55 to 8.39. The mean scores of the organoleptic test were in the category of score 9, which is fishy and savory. The difference in the addition of kappa carrageenan edible coating did not affect the taste of fried fish cake.

The determination of water content was with the aim to determine the water content contained in fried fish cake. The high temperature in frying process of fish cakes, which is 170^{0}C, causes a evaporation of water on the surface of fried material (Bouchon 2009). Fish cake with the addition of kappa carrageenan edible coating produced a higher water content compared to the fish cake without the addition of edible coating. It was because the edible coating of kappa carrageenan will form a layer and attach to the fish cake which will keep the water in it. The edible coating layer serves as a barrier to the process of evaporation of water during the frying process (Porta, et al. 2012).

The test of ash content was aimed to determine the content of inorganic ingredients in fried fish cake. The value of ash content in fish cake ranged from 7.298% to 7.508%. The results of ash content in the fried fish cake without the addition of kappa carrageenan edible coating had the lowest ash content of 7.322%. Whereas, the ash content with the addition of edible coating of 3% carrageenan kappa contained the highest ash content of 7.508%. The difference in the results of high ash content from fish cake is caused by the addition of kappa carrageenan edible coating. Edible coatings added will stick to the frying process so that the kappa carrageenan edible coating added to fish cake had an effect on ash content.

The test of fat was aimed to determine the fat content in fried fish cake after the frying process. The frying process in fried fish cake causeda an increased fat levels. Increased fat content in fish cake during frying is caused by the oil entering replaces the position of water in the material (Mallema 2003). The results of fat content in the fish cake without the addition of edible coating of carrageenan kappa had the highest fat content of 9.37%. Whereas, the fish cake with the addition of edible coating with a concentration of 3% carrageenan kappa had the lowest fat content value of 4.72%.

The fat content of fish cake with edible coating of kappa carrageenan showed a lower value compared to fish cake without the provision of edible coating. This was due to the carrageenan kappa edible coating that attached and coated fish cake products that function as a barrier during frying. The barrier function of the edible coating of carrageenan kappa wass to prevent the evaporation process of water in fish cake during frying. Evaporation of water which decreases during frying caused a reduction in oil absorbed in fish cake.

Level of protein in fried fish cake with the addition of edible coating of carrageenan kappa was higher compared with fish cake without edible coating of kappa carrageenan. The high protein in fish cake with the addition of kappa karaginan edible coating due to the function of the edible coating of kappa caraginan itself is as a protector of the evaporation process of water during the frying process (Porta, et al. 2012). So that when the water in the material during the frying process slightly evaporates, the protein that is soluble in water slightly decreases.

The results of the assessment of mean organoleptic score for aroma parameters ranged from 6.71 to 7.04. The results of mean score in P0, P1, P2 and P3 were included in category 7 which means that it had fish aroma. The assessment results of mean scores of the organoleptic test for taste parameters ranged from 7.55 to 8.39. Mean scores in P0, P1, P2 and P3 had score included in category 9, which was fishy and savory. This showed the addition of edible coating of kappa carrageenan in fish cake did not affect the aroma and taste.

Based on the results of this study, the effects of edible coating of kappa carrageenan as an oil reducer on fried fish cake were: firstly, reducing oil in fried fish cake was significant. Second, the addition of edible coating of kappa carrageenan with a concentration of 1% was the precise concentration regarding the content of low fat content, water content, ash content and high protein content in fish cake. It may be a suggestion from researchers for further research on the effect of edible coating of kappa carrageenan as a reducing oil on fried fish cake with the addition of 1% concentration which have low fat content. Addition of edible coating of kappa carrageenan can be applied to other fried products so that it can reduce oil absorption in the product and become a healthier product to consume.

4. CONCLUSION

Edible coating kappa carrageenan can reduce the oil content on fried fish cake. The administration of the edible coating of kappa carrageenan with a concentration of 1% was the best treatment for reducing oil in fried fish cake.

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