

## THE EFFECT OF KAPPA CARRAGEENAN ADDITION ON THE EMULSION STABILITY OF MILKFISH (*Chanos chanos*) SAUSAGE

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### ABSTRACT

Fish sausage is a processed fish product in the form of an emulsion, so that the stability of the emulsion is one of the most important factors for the success of the product. The aim of this study is to find out the effect of kappa carrageenan as a hydrocolloid in increasing the emulsion stability and determining the best concentration of kappa carrageenan based on the value of emulsion stability and the characteristics of milkfish sausage. The research method used was experimental laboratories with a completely randomized one-factor design using ANOVA, which was then continued with the HSD test. Organoleptic value data were analyzed using the Kruskal-Wallis and Mann-Whitney tests. The concentrations of kappa carrageenan used were 0%;0.5%;1%;1.5 with 3 repetitions. The results of the study show that kappa carrageenan addition has a significant effect ( $p < 0.05$ ) on the value of emulsion stability, sensory, moisture content, gel strength, and water holding capacity. The concentration of 1% kappa carrageenan (P2) was the best concentration with quality criteria: sensory of  $8.14 < \mu < 8.32$ , moisture content of 63.02%, water holding capacity of 55%, gel strength of 1200.14 g.cm, and emulsion stability of 83.23. Compared to other treatments, fish sausage with the addition of 1% kappa carrageenan has the brightest appearance according to the specific color of the product, has a chewy texture and solid but not hard, and has the highest value of emulsion stability.

**Keywords:** emulsion stability; fish sausage; kappa carrageenan; milkfish

### INTRODUCTION

Milkfish (*Chanos Chanos*) is a type of brackish water fish with important economic value and is growing rapidly due to many milkfish cultivations in Indonesia. The production of milkfish continues to increase by year. According to the KKP (2020), the catches of milkfish were 701,427 tons in 2017, 822.372 tons in 2018, 830.263 tons in 2019 and 875.486 tons in 2020 with the average increase is 24,3% from 2017 until 2020 and the chemical composition of milkfish based on research by Ratnaningtyas *et al.*, (2016), milkfish has the advantage of delicious taste and contains 66.45% water, 0.85% fat, 24.18% protein and 2.78% ash. Even though the production level is high, many people are not interested in milkfish because it has many fish bones, so people prefer to consume processed milkfish. One of the processed innovations from milkfish is sausage.

Sausage is a food made from mashed beef with the addition of fillers and seasonings wrapped in a casing then boiled. The problem that often occurs in making sausages is the break of emulsion on the dough, causing the texture of sausage is not compact, too hard or too soft, and low water holding capacity. Based on Yulistiani *et al.*, (2013), sausage is a type of emulsion food. The form of sausage emulsion is oil in the water (o/w) consisting of the mixture of fat and water in the colloid phase with protein as an emulsifier. According to

Yufidasari *et al.*, (2018), the emulsion can be formed during the dough making so the break of emulsion occur during that process. Its occur because the protein can not properly cover the fat so that the fat will come out from the emulsion system. The break of emulsion on the dough will affect to the texture and consumer's acceptance.

The prevention that can be performed so that the emulsion is not easily broken is by adding an emulsifier or substance that can maintain the stability of the product. Emulsifier that added in the process of making milkfish sausage is kappa carrageenan. This type of carrageenan has the ability to bind water and other hydroxyl groups so that the emulsion stability in the sausage can increase. According to Putra *et al.*, (2015), carrageenan can be function as an emulsifier, a basic ingredient for gel making, stabilizer, and material that can increase viscosity. Carrageenan added in the fish sausage must have precise concentration, not too low or too high. Based on Candra *et al.*, (2014), the more the concentration of carrageenan added, the more fat is released. Loss of fat in the dough will result in low emulsion stability of the product.

Based on the description, it is necessary to find out the effect of kappa carrageenan as a hydrocolloid in increasing the emulsion stability and determining the best concentration of kappa carrageenan based on the value of emulsion stability and the characteristics of milkfish sausage.

## RESEARCH METHODS

### Tools and Materials

The raw materials that used to make milkfish sausage were milkfish that ordered from MSME Manda Food, Semarang in fresh condition with the size of the milkfish is  $\pm$  500-600 g and the length is  $\pm$  25-30 cm, while the kappa carrageenan was obtained from Kappa Carrageenan Nusantara Inc. Other materials used in making fish sausage were tapioca flour (Sagu Tani), skim milk (Indomilk), garlic, salt (Refina), pepper (Ladaku), egg(s), cooking oil (Sanco), and cool water. All of these ingredients were obtained from traditional market in Semarang.

The tools that used to make milkfish sausage were blender, analytical scale, plastic basin, knife, cutting board, saucepan and sausage filler. The tools used in the analysis of milkfish sausage were texture analyzer (Lloyd), centrifuge (WINA), oven (Mettler) and desicator (Gerhardt).

All processes from making and testing the milkfish sausage were carried out at the Fisheries Technology Laboratory, Diponegoro University. Fish sausages was made in the processing laboratory, while the tests were carried out in the analysis laboratory.

### Preparation of Fish Sausage

A study regarding fish sausage made from milkfish with the addition of kappa carrageenan as emulsifier refers to modified research procedures by Widjanarko *et al.*, (2012). The process of making sausage began by separating the fish meat from the head, fishbone, fins, skin, entrails, and tails. The 55% meat was washed, then mashed and weighed. After that, the meat was mixed with 1% garlic, 1% pepper powder, 1% salt, 2% skim milk, 6% vegetable oil, 1% egg white and 12% ice water. The dough that has been mixed with other materials then added with carrageenan flour and tapioca flour for each treatment (K = 0% : 20%, P1 = 0.5% : 19.5%, P2 = 1% : 18%, and P3 = 1.5% : 18.5%) until homogeneous After the dough homogeneous, the dough was put into the casing then boiled for 30 minutes in boiling water over low heat until it floats.

### Testing Method

The testing method used is emulsion stability test (AOAC, 2007), moisture content test (AOAC, 2006), gel strength test (BSN, 2009), water holding capacity test (Zhang *et al.*, 1995), sensory test with 30 panelist (SNI 7753:2013).

### Data Analysis

This study was conducted by experimental laboratories method. The trials were designed with Completely Randomized Design (CRD) with the different concentration treatments of 0%, 0.5%, 1%, and 1.5% with 3 repetitions. Data obtained from emulsion stability test, moisture contents test, gel strength test, water holding capacity test were performed normality test and homogeneity test, followed by analysis using ANOVA. If the results show a

significant difference, the test was continued with the HSD test (Honestly Significant Difference). The data of the sensory test was analyzed using Kruskal-Wallis. If the data showed a significant difference result, then it was continued with the Mann-Whitney test.

## RESULT AND DISCUSSION

### Emulsion Stability

The results obtained from emulsion stability analysis on milkfish sausage with the addition of different concentrations kappa carrageenan are presented in Table 1.

**Table 1.** Emulsion Stability on Milkfish Sausage with The Addition of Different Concentrations Kappa Carrageenan

Treatment	Emulsion Stability	Candra <i>et al.</i> , (2014)
K	80,36 $\pm$ 0,77 <sup>a</sup>	72,20 $\pm$ 3,17 <sup>a</sup>
P1	81,46 $\pm$ 0,94 <sup>b</sup>	86,90 $\pm$ 1,16 <sup>b</sup>
P2	83,23 $\pm$ 0,65 <sup>b</sup>	79,70 $\pm$ 4,12 <sup>c</sup>
P3	81,74 $\pm$ 0,64 <sup>b</sup>	77,30 $\pm$ 2,23 <sup>d</sup>

The treatment of adding different concentrations of kappa carrageenan showed a significant difference in the emulsion stability value. The emulsion stability measurement of milkfish sausage showed results 80.67 to 83.23. Milkfish sausage with the addition of kappa carrageenan showed a higher emulsion stability value than fish sausage without the addition of kappa carrageenan. This is in accordance with the study by Ramasari *et al.*, (2012), which stated that a mackerel sausage with the addition of carrageenan has a higher emulsion stability value than a mackerel sausage without the addition of carrageenan. This statement is supported by Putra *et al.*, (2015), which stated that carrageenan has hydrophilic properties that can bind water and stabilize the emulsion system in emulsion products. The increase of emulsion by carrageenan is carried out by binding the water in the protein tissue. The ability of binding water by carrageenan will be better if there is a chemical interaction between protein and water.

The addition of kappa carrageenan can stabilize the emulsion because kappa carrageenan gradually can decrease the surface tension. However, the addition of too much kappa carrageenan can cause a decrease in the emulsion stability of the product. Sausage with the addition of 1% carrageenan had the highest emulsion stability of 83.23%, then a decrease in emulsion stability value occurred in the addition of 1.5% kappa carrageenan. The higher the concentration of carrageenan added, the more fat is released. Loss of fat in the dough will result in low emulsion stability of the product. This is in accordance with the study by Rifani *et al.*, (2016), which stated that the addition of 1% carrageenan on shrimp *pempek* resulted in the highest emulsion stability while the addition of 2% and 3% carrageenan resulted in a decreased. The higher the concentration of carrageenan used, it is assumed to be able to decrease the emulsion stability value because the more carrageenan added, the more oil will be released so that emulsion becomes unstable and easy to break. This can occur because carrageenan has more water-binding properties than fat binding.

### Moisture Content

The results obtained from moisture content analysis on milkfish sausage with the addition of different concentrations kappa carrageenan are presented in Table 2

**Table 2.** Moisture content on Milkfish Sausage with The Addition of Different Concentrations Kappa Carrageenan

Treatment	Gel Strength (g.cm)	Athaskar <i>et al.</i> , (2018)
K	911,24±54,21 <sup>a</sup>	1412,50 ± 230.55
P1	1118,06±76,87 <sup>b</sup>	2980,60 ± 54.90
P2	1200,14±45,85 <sup>b</sup>	1318,17 ± 65.12
P3	1375,02±61,44 <sup>c</sup>	2316,17 ± 78.46

Based on Table 2. the treatments of adding kappa carrageenan with different concentrations showed a significant difference in the moisture content of milkfish sausage. Moisture content is a physical characteristic of the material, indicating the amount of water in the material. As a hydrocolloid, carrageenan has the ability to bind water in huge amounts. Carrageenan has a free OH<sup>-</sup> ion that can combine with H<sub>2</sub>O to strengthen the bond. The moisture content value of milkfish sausage obtained has been in accordance with the National Standard, which is required that the maximal moisture content of fish sausage is 68% and in this research the moisture content have the lower value from the National Standard. The highest moisture content of milkfish sausage was control treatment (64.11%), and the lowest moisture content was treatment 3 (61.42%). The higher the concentration of kappa carrageenan added, the moisture content of milkfish sausage will decrease. It's happen because kappa carrageenan has hydrocolloid properties and ability to absorb water. This statement is in accordance with the study conducted by Isnanda *et al.*, (2016), which stated that carrageenan functions as an emulsifier, stabilizer, thickener and is able to increase the viscosity value of the material. The addition of more carrageenan concentration causes the increase of total dissolved solids, which causes the viscosity value of the materials to increase. This increase in viscosity value will reduce the amount of moisture content in the materials and based on Mastuti (2008) in Sitompul *et al.*, (2016), the addition of carrageenan in general has reduced the moisture content of the sample. The decrease in moisture content was due to carrageenan having a hydrophilic group that capable of forming strong bonds with water molecules contained in the meat emulsion system.

Additional materials added during the process of making milkfish sausage also affected the moisture content value, one of them is tapioca flour. The moisture content of milkfish sausage without the addition of carrageenan was higher. This is because the addition of tapioca flour more than kappa carrageenan in making milkfish sausage. Based on Cato *et al.*, (2015), tapioca flour has the ability to bind water properly so that water is not easily separated from the materials. Generally, the addition of tapioca flour is to create certain characteristics or texture in the product through its ability to bind the water. Differences in moisture content value also occur due to the treatment in the material. One of the treatments in making sausages that affect moisture content value is boiling. According to Ramasari *et al.*, (2012), during the heating process, water will be trapped in the carrageenan

matrix which causes changes in moisture content. Carrageenan contains sulfate groups that are negatively charged along the polymer chain and are hydrophilic so they can bind water properly.

### Gel Strength

The results obtained from gel strength analysis on milkfish sausage with the addition of different concentrations kappa carrageenan are presented in Table 3.

**Table 3.** Gel Strength on Milkfish Sausage with The Addition of Different Concentrations Kappa Carrageenan

Treatment	Gel Strength (g.cm)	Athaskar <i>et al.</i> , (2018)
K	911,24±54,21 <sup>a</sup>	1412,50 ± 230.55
P1	1118,06±76,87 <sup>b</sup>	2980,60 ± 54.90
P2	1200,14±45,85 <sup>b</sup>	1318,17 ± 65.12
P3	1375,02±61,44 <sup>c</sup>	2316,17 ± 78.46

Based on Table 3, it can be seen that the addition of kappa carrageenan with different concentrations had a significant effect on the gel strength value of milkfish sausage. The highest gel strength value of milkfish sausage was in the P3 treatment (the addition of 1.5% kappa carrageenan) of 1275.02 g/cm, and the lowest gel strength value was in the K treatment (fish sausage without the addition of kappa carrageenan) of 911.24 g/cm. Carrageenan is generally added in foodstuffs to increase gel formation to improve product elasticity. The formation of gel by carrageenan is form by the presence of water and proteins that are bound together so they have ability to withstand external pressure and return to its original form when pressed. The more the concentration of kappa carrageenan added, the higher the gel strength value. This is believed according to the ability of kappa carrageenan as a gelling agent through interactions with charged molecules, such as protein. According to the study by Athaskar *et al.*, (2018), the more carrageenan concentration added, the higher the gel strength value of the sausage. The increase of this gel strength value causes the sausage texture to be hard due to the reaction between dissolved protein and salt that produces gel. The high gel strength on fish sausage is also influenced by the ability of carrageenan in binding water. The addition of high kappa carrageenan concentrations will cause the carrageenan to bind more water so that the moisture content and gel strength values be inversely proportional. This is strengthened by Mawarni and Yuwono (2018), which stated that if the moisture content value in the system is low, then the bond between the gel matrix is stronger and will affect the harder texture of the materials. It's happen because the high and low strength of the gel depends on the amount of moisture in the materials. The higher the free food moisture content, the lower the gel strength, and the lower the free food moisture content, the higher the gel strength value.

The process of gel formation on milkfish sausage by carrageenan begins with the interaction between carrageenan and protein that causes the gel in the product to be stronger. Interaction between protein and carrageenan will cause the combination of polymer chains, which then form a three-dimensional net. This net will absorb water, which then causes milkfish sausage to be strong and stiff. Based on the study by Safitri *et al.*, (2017), a gel is formed when the chains between carrageenan meet, which then will form a double helix. After

that, this double helix chain will join together and form three-dimensional tissues (triple helix). Besides the formation of triple helix tissue, the gel is formed due to the cation ion in the kappa carrageenan that also has the ability to increase the gel.

### Water Holding Capacity

The results obtained from water holding capacity analysis on milkfish sausage with the addition of different concentrations kappa carrageenan are presented in Table 4.

**Table 4.** Water Holding Capacity on Milkfish Sausage with The Addition of Different Concentrations Kappa Carrageenan

Treatment	Water Holding Capacity (%)	Rifani <i>et al.</i> , (2016)
K	51,00 ± 1,00 <sup>a</sup>	15,97 ± 1,10 <sup>a</sup>
P1	53,33 ± 0,57 <sup>a</sup>	20,77 ± 1,82 <sup>b</sup>
P2	55,00 ± 1,00 <sup>b</sup>	26,51 ± 1,59 <sup>c</sup>
P3	56,67 ± 1,15 <sup>b</sup>	38,63 ± 2,10 <sup>d</sup>

The addition of carrageenan on milkfish sausage was to inhibit the loss of water holding capacity during the heating process, which will affect other parameters, such as moisture content, gel strength, and texture. Based on Table 4, milkfish sausage with the addition of kappa carrageenan had a significant effect on the water holding capacity of milkfish sausage. The highest water holding capacity of milkfish sausage was obtained in the P3 treatment (the addition of 1.5% kappa carrageenan) of 56.67%, while fish sausage without the addition of kappa carrageenan (control) had the lowest water holding capacity of 51%. The more the kappa

carrageenan added, the higher the ability of sausage in binding water. Milkfish sausage with the addition of kappa carrageenan had a better ability in binding water than milkfish sausage without the addition of kappa carrageenan. According to the study by Ganesan *et al.*, (2019), the water holding capacity value of chicken sausage with the addition of carrageenan shows a value of 78.26% to 88.48%. The higher water holding capacity value is proportional to the increase of carrageenan concentration added. One of the high-water holding capacity values is influenced by potassium ion contained in the carrageenan, which binds to Ca<sup>2+</sup> on meat protein forming matrix structure that will assist in the water-binding process.

It is important for fish jelly products to have a high-water holding capacity. The content of high free water can affect the shelf life, texture, and elasticity of fish jelly products. Water holding capacity value is inversely proportional with the moisture content value of the product and directly proportional to the ability of the product to form a gel. Based on Wulandari *et al.*, (2016), the higher water holding capacity will affect the viscosity value of gel so that the elasticity of the product increases and affects the elasticity. The higher the water holding capacity value, the more supple the product, and the lower the water holding capacity, the lower the elasticity of the product.

### Sensory Test

The results obtained from sensory test on milkfish sausage with the addition of different concentrations kappa carrageenan are presented in Table 5.

**Table 5.** Sensory Test on Milkfish Sausage with The Addition of Different Concentrations Kappa Carrageenan

Treatment	Parameters				Sensory
	Appearance	Odor	Taste	Texture	
K	7,23 ± 0,86 <sup>a</sup>	8,00 ± 1,15 <sup>a</sup>	7,67 ± 0,96 <sup>a</sup>	7,53 ± 0,90 <sup>a</sup>	7,71 < μ < 7,89
P1	8,20 ± 0,99 <sup>b</sup>	8,23 ± 0,98 <sup>a</sup>	7,60 ± 0,93 <sup>a</sup>	8,33 ± 0,96 <sup>b</sup>	7,78 < μ < 7,98
P2	8,23 ± 0,98 <sup>b</sup>	8,47 ± 0,90 <sup>a</sup>	7,87 ± 1,00 <sup>a</sup>	8,53 ± 0,86 <sup>b</sup>	8,14 < μ < 8,32
P3	8,13 ± 1,00 <sup>b</sup>	7,60 ± 1,50 <sup>a</sup>	7,53 ± 0,90 <sup>a</sup>	7,40 ± 0,81 <sup>c</sup>	7,65 < μ < 7,85

### Appearance

Based on the Table 5. the addition of kappa carrageenan with different concentrations showed a value that is not significantly different on the odor and taste parameters but significantly different on the appearance and texture parameters of milkfish sausage. The results of the sensory test for the appearance parameter of milkfish sausage had a range value of 7.23 to 8.23, indicating that the appearance of milkfish sausage can be accepted by the panelists. The addition of kappa carrageenan in different concentrations of 0.5%, 1%, and 1.5% had a higher appearance value with a specific bright appearance (brown), sold, and compact compared to treatment without the addition of kappa carrageenan. Fish sausage without the addition of kappa carrageenan has a less bright color (pale brown), is less compact, and has several air cavities in the sausage. According to Santoso in the Sipahutar *et al.*, (2020), the treatment of adding carrageenan with different concentrations provides a significant effect on the appearance value of fish sausage. Carrageenan has the function of increasing the gel strength value of the product. By increasing gel strength, a

meaty and more compact appearance can be produced. Based on Tarwendah (2017), one of the important components in food is color. This is because color can be an attraction for consumers to give the impression of whether a product is liked or not. Moreover, color also can be an identification and quality attribute.

### Odor

The results of the sensory test for odor parameter on milkfish sausage with the addition of different kappa carrageenan concentrations had an average value of 7.60 to 8.47, indicating that the odor of milkfish sausage can be accepted by the panelists. The highest average value of odor was milkfish sausage with the addition of 1% kappa carrageenan, and the lowest value was milkfish sausage with the addition of 1.5% kappa carrageenan. The addition of kappa carrageenan on milkfish sausage did not affect the odor of milkfish sausage because the savory odor of milkfish meat and other seasonings was more dominant than the odor of carrageenan flour. This is because kappa carrageenan flour has no odor or has a neutral odor so that when it is added to

fish sausage dough, it will not have a significant effect on the odor of fish sausage. The same thing was stated by Yakhin (2015) that the addition of carrageenan flour on a product does not affect the odor of the product because carrageenan has a neutral odor, and the addition of carrageenan is still on a small scale.

### Taste

The results of the sensory test for the taste parameter of milkfish sausage with the addition of various concentration of kappa carrageenan had value of 7.53 to 7.87 so that it can be concluded that taste in all treatments of milkfish sausage can be accepted by the panelists. The highest average value was in the addition of 1% kappa carrageenan, and the lowest value was in the addition of 1.5% kappa carrageenan. The overall taste of fish sausage was not different, where the taste of fish is not too strong, savory, and does not have an aftertaste. Furthermore, the addition of kappa carrageenan did not affect the taste of fish sausage. Based on Nurhuda *et al.*, (2017), carrageenan flour has a neutral taste or is tasteless. Carrageenan added to *bakso ikan manyung* (ariid catfish meatball) will not affect the taste of the product resulted. However, in the P3 (sausage with addition kappa carrageenan 1.5%), the taste of fish sausage is less product-specific because fish in the sausage cannot be tasted. The savory taste of milkfish sausage is affected by the fish meat that used. Milkfish meat is known to have a quite savory taste. Based on Fitri *et al.*, (2016), the advantage of milkfish compared to other fish is its a quite savory taste. Moreover, the taste of the meat is neutral or not salty and not easily wrecked when cooked.

### Texture

Sausage includes in a fish jelly product, and texture is an important thing and must be considered. Generally, the fish jelly product has a chewy texture. The texture of sausage can be seen based on the level of elasticity, compactness, and solidity of the sausage. The results of the sensory test for texture parameter on milkfish sausage with the addition of different kappa carrageenan concentrations had value of 7.40 to 8.53, indicating that the texture of milkfish sausage can be accepted by the panelists. The average value of fish texture increases from control to treatment 1 or the addition of 1% kappa carrageenan, but the average value of texture experience decreases on fish sausage with addition of 1.5% kappa carrageenan. The highest value of fish sausage texture was in the P2 (the addition of 1% kappa carrageenan) with a solid, compact, and quite elastic texture. Meanwhile, the lower value of fish sausage texture was in the P3 (addition of 1.5% kappa carrageenan) with too solid and compact product causing the sausage to be less chewy. The more kappa carrageenan added, the more solid and hard the sausage texture will be because kappa carrageenan has the ability to improve the product elasticity and form a solid texture. Based on Nurhuda (2016), the gel formation produced by carrageenan is a combination or a crossing between polymer chains forming a strong and rigid three-dimensional net. The more the carrageenan is added to a product, it can cause too hard gel formation. This statement is supported by Supriyani *et al.*, (2017), which stated that carrageenan is generally used to improve the texture. A good texture results in a chewy and

compact product. Interaction between carrageenan and charged macromolecules, such as protein, can affect the viscosity value, gel formation, and product stability.

### CONCLUSION

The conclusions that can be drawn from the study about the Effect of Kappa carrageenan Addition on the Emulsion Stability of Milkfish (*Chanos Chanos*) Sausage are the addition of kappa carrageenan on milkfish sausage with different concentrations has a significant effect ( $P < 0.05$ ) on the emulsion stability and characteristics of the milkfish sausage product. Milkfish sausage with kappa carrageenan has more stable emulsions, high water holding capacity, lower moisture content and better gelling ability. Based on this capability, the addition of kappa carrageenan resulted in a better milkfish sausage texture and a longer shelf life. The best concentration for the addition of kappa carrageenan on milkfish sausage is the addition of 1% kappa carrageenan that has sensory value of  $8.14 < \mu < 8.32$ , moisture content value of 63.02%, water holding capacity value of 55%, gel strength value of 1200.14 g.cm, and the highest emulsion stability value of 84.63. The addition of 1% kappa carrageenan has the best appearance based on the product-specific color and has a chewy and solid texture but not hard.

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