The characteristics of nanocalcium flavor powder made from waste stewed water of swimming crab *Portunus pelagicus* L.

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Abstract. The waste stewed water of swimming crab contains volatile compounds, proteins, and minerals, therefore it has the potential to be a food flavor as well as a food additive. Flavor with addition of nanocalcium powder is limited availability and a good source as the calcium enhancer flavor. This study aimed to determine the effect of adding nanocalcium from tilapia bones and maltodextrin combinations on crab flavor powder's characteristics. The filler materials used 15% combination which were nanocalcium and maltodextrin as follow 0% nanocalcium and maltodextrin 15% (A); 1.5% nanocalcium and maltodextrin 13.5% (B); 3% nanocalcium and maltodextrin 12% (C); 4.5% nanocalcium and maltodextrin 10.5% (D). The test parameters that were used such as solubility, yield, moisture content, protein content, glutamic acid, calcium content, particle size analyzer, and hedonic scale. The results showed that treatment of different filler combinations had a significant effect on solubility, water content, protein content, Aw, glutamic acid and calcium levels (P < 0.05). The best treatment showed in combination of 3% nanocalcium and 12% maltodextrin (C), having the highest solubility of 98.27%; low water content (11.46%); the lowest Aw (5.21); 7.2% protein content and 23.45% yield with hedonic value of 7.08 indicating that panelists preferred that product.

I. Introduction

Swimming crab (*P. pelagicus* L.) is one of the fisheries commodities that have high economic value. Ministry of Maritime Affairs and Fisheries (2018), stated that the value of exports of crab meat in Indonesia in 2017 ranked fourth largest after shrimp and tuna which were 22.8 million tons with a value of 411 million US dollars. The Central Java region showed crab production was about 129 tons in 2010. Crab production will certainly produce waste from the crab stripping process [1]. In a single swimming crab produced processing waste consisting of 57% shells, 3% body rejects, and 20% boiled water. Swimming crab stewed water is swimming crab liquid waste that has potential as flavorings because it contained 17 amino acids with glutamic acid levels reaching 0.04% (w/v) [2] and it can be utilized by processing it into flavor products.

Flavor is a material that gives aroma and taste and emphasizes the taste that is often added to food. However, the number of synthetic flavors in the market which if consumed in excessive amounts has an effect on health [3]. Currently, there is not many natural flavor or flavor that has the aroma and taste of seafood. Therefore, making a natural flavor powder from meat processing waste of swimming crab has the potential as an alternative flavor, food or snack.

Nanocalcium is a form of calcium in nanoparticles sizes approximately 10-10000 nm. Nanocalcium is in the form of fine powder which can be directly applied in various foods and non-foods. Nanocalcium is often added to food to gain more nutrition through fortification to help fulfill the body's
calcium needs, which is an average of 1.000 mg/day and in children aged 10-18 years is 1.200 mg/day. Making a flavor requires natural fillers which are used to improve the texture of the flavor. In the process of making flavor, filler material is needed to increase the yield, coat the flavor components, increase the drying process, prevent damage to the material due to heat and improve the solubility and organoleptic characteristics of flavor powder. Filler materials in flavor are usually from starch hydrolysis such as dextrin, maltodextrin, arabic gum and CMC.

Maltodextrin is one type of natural fillers that can be used for binding the flavor components. Maltodextrin is a starch hydrolysis product consisting of a mixture of glucose, maltose oligosaccharides and dextrin. The advantage of maltodextrin is that it dissolves easily in cold water. As a thickening and stabilizing agent, maltodextrin has the ability to form a film that is stable during frying. It can prevent so much oil absorption of which causes the product to be dry, give oily taste and reduce the absorption of water vapor [4]. Besides maltodextrin, nanocalcium can also be used as filler as well as a calcium enhancer in the swimming crab stewed water flavor.

Research on flavor making from the by product of canning swimming crab such as from shells, lemi (eggs swimming crab) and swimming crab stewed water has been done [2,5,6,7]. However, a study of swimming crab flavor that is enriched by nanocalcium has never been done. The addition of nanocalcium and maltodextrin to the flavor of boiled water is expected to produce a calcium-rich flavor, fulfill the standards and preferred by panelists.

Swimming crab stewed water contains volatile compounds, proteins, and minerals that come out of the swimming crab resulting wastewater with high BOD. Water containing high BOD will pollute the environment if thrown away. To minimize environmental pollution, steaming waste can be processed into economically valuable products. Swimming crab boiled water contains high solid 206.5 mg / L; protein 0.88%; NPN 0.23% [2]. The content shows that the swimming crab boiled water has the potential to be processed into food flavor. Swimming crab flavor can be used for a variety of processed products including imitation crab meat from surimi or added to other food products.

Nanocalcium that was used comes from the bones of tilapia and the natural flavor has the potential to be added to food for all ages. The addition of nanocalcium powder is as filler material as well as calcium enhancer to the flavor. The resulting flavor has excess containing high calcium so that it can be added to foods that are low in calcium. The use of nanocalcium is thought to influence the physical, chemical and sensory characteristics of flavor, among others: particle size, solubility, yield, protein content, glutamate acid, calcium content and panelist preference level. The content of fillers in flavor used is usually 10-15%. In this study, the filler materials used were 15% which is a combination of maltodextrin and nanocalcium namely (nanocalcium 0% and maltodextrin 15%); (nanocalcium 1.5% and maltodextrin 13.5%); (nanocalcium 3% and maltodextrin 12%); (nanocalcium 4.5% and maltodextrin 10.5%). This study aimed to determine the effect of adding tilapia bones nanocalcium on the physical, chemical and sensory characteristics of the swimming crab flavor.

2. Methods

2.1. The process of made fish bone nanocalcium

Nanocalcium processed is based on research from [8], that was tilapia bone was mashed using a blender to obtain a coarse powder of fish bones. Afterwards, the process was extraction with NaOH 1 N 100˚C (3 times steamed), then cooled, fibrated and neutralized. The sample was then dried at 50˚C on (moisture content<8%), ball milled, and sieved as a formed of nanocalcium.

2.2. The processed of flavor powder

Swimming crab was stewed in the water and the waste of stewed water that has been filtered was mixed with a filler. The filler combinations were nanocalcium and maltodextrin by 15% (nanocalcium 0% and maltodextrin 15%); (nanocalcium 1.5% and maltodextrin 13.5%); (nanocalcium 3% and maltodextrin 12%); (nanocalcium 4.5% and maltodextrin 10.5%). The mixture was then stirred until homogeneous, then carried out drying with a spray dryer with an inlet temperature of 130˚C and
an outlet of 70°C. Natural food flavoring powder that has dried in the form of powder was put into a plastic seal and stored in the freezer for further analysis.

2.3. Yield

The yield was determined according to the percentage of total mass of chlorophyll microcapsule produced and the total mass of solid before drying [9].

2.4. Particle Size Analyser (PSA)

The measurement of nanocalcium size and flavor powder was carried out using PSA (Particle Size Analyzer). The particle size of the double emulsion and seasoning was measured using a laser diffraction particle size analyzer (LS-PSA) (Beckman Coulter, USA) with a measurement range of 0.4-900 µm. The LS-PSA was connected to a computer equipped with the LS Coulter 100 software. The dispersant used was aquades. Aquades was poured into the sample hole until it filled the entire hole, then the sample was dropped until it reached a reading range of 8-12%. All samples were analyzed based on the Fraunhofer model in the LS Coulter 100 software. The particle size unit of the instrument used was µm.

2.5. Solid solubility

One gram of sample was dissolved into 20 ml of distilled water and it was heated in a water bath at 60°C for 30 minutes. Supernatant was separated using a centrifuge with a speed of 3,000 rpm for 20 minutes and then 10 ml was taken to be dried in the oven. Dry sediment weight was recorded [9].

2.6. Water content (AOAC,2005)

The sampled were taken as much as 2 grams, placed on cups made of aluminum, and heated in an oven for 4 h at a temperature of 105-110°C. The cups made of aluminum were then cooled in a desiccator until a constant weight [10].

2.7. Protein content (AOAC,2005)

Samples were weighed at 0.5 grams, then put into 100 ml Kjeldahl flasks, added 0.5 grams of selenium and 3 ml concentrated H₂SO₄. The sample was degraded at 410°C for about 1 hour until the solution was clear and then cooled. After chilling, 50 ml of distilled water and 20 ml of NaOH 40% were added to the Kjeldahl flask, then the distillation process was carried out with a distillation temperature of 100°C. The distillation results were collected in a 125 ml erlenmeyer flask containing a mixture of 10 ml of 2% boric acid (H₃BO₃) and 2 drops of methyl red indicator. The distillation process was stopped, and then the distillate was titrated with 0.1N HCl until the color changed into pink [10].

2.8. Glutamic acid content (SNI No. 06-3731-2009)

The total N value based on the Kjeldahl method which referred to SNI No. 06-3731-2009. The 0.1-0.2 grams of sample and put into a Kjeldahl flask and then added 5 grams of selen mixture and 20 ml of concentrated sulfuric acid. Then, heated it in the acid chamber with a small flame first while shaking it and after 5-10 minutes the flame was raised until the liquid turned green then cool the sample. The samples was diluted with 50 ml of water and then move it to a 250 ml boiling flask then added 40 ml of 4% NaOH and distilled it for 50 minutes. The distillates were collected in Erlenmeyer containing H₃BO₃ 2 and titrated with 0.1N HCl [11].

2.9. Calcium (10)

Calcium determined using the principle of calcium precipitated as calcium oxalate. The precipitate was then dissolved in a hot watery H₂SO₄ and titrated with KMnO₄. The first step was to asphyxiate the sample by means of a porcelain cup dried in a 105°C oven for several hours, then cooled in an excavator and the initial weight measured by weight. The sample material is weighed as much as 5 grams and put into a porcelain cup. Samples were burned on a Bunsen burner flame, and then put into
a mavel with a temperature of 540 °C for 8 hours. The white ash sample was then removed and cooled in an excavator for 1 hour then weighed again. A total of 2 ml of the dried ash solution was put into a 250 ml cup. Added 30 ml of distilled water then 10 ml of ammonium oxalate solution and 2 drops of methyl red indicator in ash solution in pH. The solution was heated to boiling, then let stand for 4 hours at room temperature. Filtering was done with Whatman filter paper number 42 and rinsed with aquaest until the oxalate-free filtrate, the final filtrate must be Cl− free, tested using AgNO3. The tip of the filter paper was perforated using a glass rod, and then rinsed and the precipitate was moved with liquid H2SO4 into a glass cup where the calcium is precipitated. Then rinse one more time with hot water. Hot samples (70°C-80°C) were titrated with 0.01 N KMnO4 until the first permanent pink solution occurred. Filter paper was inserted and titration was carried out until the second permanent pink color occurred.

2.10. Hedonic (SNI 01-2346-2006)

Hedonic tests based on and it measured the level of preference for a product by using an assessment sheet; generally the sample evaluation specifications tested include smell, taste, color, texture and appearance. Test ratings are based on panelist preference level [12].

2.11. Statistical analysis

Those data were analyzed using SPSS 16 with triplication. Data were analyzed using one-way ANOVA with Kruskall-Wallis and Mann-Whitney test.

3. Results and Discussions

3.1. Characteristics of Nanocalcium from Tilapia Bones

| Table 1. Characteristics of nanocalcium from tilapia bones |
|---|---|
| No | Parameter | Composition |
| 1 | Particle size (nm) | 301.25 ± 19.03 |
| 2 | Calcium content (%) | 35.016 ± 1.404 |
| 3 | Yield (%) | 22.10 ± 1.68 |

Note: The data was the average of triplication ± standard deviation.

Different superscript on the same column indicates significantly different at level of α 0,05

The nanocalcium particle size showed that the calcium flour used has qualified as nanocalcium because of the particle size in the nanometer range (Table 1). Nanoparticles were defined as dispersions of particles or solid particles with sizes in the range of 10-1000 nm. In this study, the particle size of the tilapia bone nanocalcium was smaller [13] than the results of the study of [14] which showed the nanocalcium size of tilapia bones extracted with 1N NaOH of 729.9 nm, but larger than the shrimp shell nanocalcium extracted with precipitation produced by [15] was 37-127 nm. The size difference of the nanocalcium particles produced can be caused by various factors including the nanocalcium raw material and the used extraction method. The smaller the particle size of the nanocalcium, the absorption or bioavailability of calcium was also greater because the smaller the size, the faster it entered the receptor and will be absorbed perfectly [15].

Calcium content in nanocalcium flour from tilapia was 35.016%. The calcium content of this study was higher than in tuna bones flour extracted with water and acetic acid respectively 23.61% and 16.64%; The literature [14] showed calcium content of nanocalcium flour from tilapia extracted with NaOH contained calcium 19.27%. According to [16] which showed tilapia bones flour extracted with star fruit solution contained calcium 17.89% - 20.85%. The calcium content of fish bone flour depends on the raw material and the produced extract method.
3.2. Physical Characteristics of Nanocalcium from Tilapia Bones

3.2.1. Solubility

![Figure 1](image.png)

Figure 1. The solubility of swimming crab flavor with different nanocalcium concentrations.

High solubility of particles was made it easier for the flavor to dissolve in all parts on the food so as to give the desired odor and taste effect. High solubility in all flavor samples occurred due to nano particle size and high solubility of maltodextrin. The highest solubility in flavor was the addition of a combination of 3% nanocalcium with 12% maltodextrin (Figure 1). The solubility of the flavor from the boiled water residue of the swimming crab was higher than the flavor from the crab shell produced by [6] which were 74.67%. It happened because the raw material used in this study was remaining boiled water from swimming crab that contained water-soluble protein so that it was more soluble than a shell which contained inorganic materials such as calcium which was more difficult to dissolve in water. [17] reported the solubility of flavor from steaming waste in canning tuna 60.87-70.12% which showed lower than the results of this study.

3.2.2. Yield

The higher addition of nanocalcium showed a low yield in swimming crab flavor. The addition of high nanocalcium at Figure 1 (4.5%) affected on reducing the addition of maltodextrin (10.5%), hence the flavor coated by maltodextrin were also decreased. Maltodextrin has functions as filler that can increase the yield reduction in maltodextrin, also affects the reduction in yield. The flavor yield of swimming crab boiled water with the addition of 0-3% nanocalcium and 12-15% maltodextrin was higher than the flavor of tuna boiled water with the addition of 20-26% maltodextrin, the results of the study of [17] with a yield of 11-23.3%.
3.3. Chemical Characteristics of Nanocalcium from Tilapia Bones

Table 2. Chemical characteristics of nanocalcium from tilapia bones

| Parameter                  | 0%          | 1.5%         | 3%           | 4.5%         |
|----------------------------|-------------|--------------|--------------|--------------|
| Water content (%)          | 13.14 ± 0.40<sup>a</sup> | 12.43 ± 0.14<sup>b</sup> | 11.46 ± 0.27<sup>c</sup> | 10.83 ± 0.16<sup>c</sup> |
| Protein content (% db)     | 8.82 ± 0.61<sup>a</sup>  | 7.55 ± 0.19<sup>a</sup>  | 7.20 ± 0.11<sup>a</sup>  | 5.74 ± 0.69<sup>b</sup>  |
| Calcium content (%)        | 41.59±0.30<sup>d</sup>  | 46.74±0.34<sup>c</sup>  | 50.48±0.59<sup>b</sup>  | 58.05±0.35<sup>a</sup>  |
| Glutamic acid content (%)  | 18.93±0.07<sup>c</sup>  | 23.53±0.76<sup>b</sup>  | 23.53±0.01<sup>b</sup>  | 25.46±0.03<sup>a</sup>  |
| Aw                         | 0.55 ± 0.004<sup>a</sup> | 0.53 ± 0.003<sup>b</sup> | 0.52 ± 0.001<sup>b</sup> | 0.54 ± 0.01 <sup>ab</sup> |

Note: The data was the average of tri replications ± standard deviation. Different superscript on the same column indicates significantly different at level of α 0.05

There was negative relationship where the water content in flavor from swimming crab boiled water decreased followed with the increased addition of nanocalcium (Table 2). The highest water content was in flavor control (without addition of nanocalcium), while the lowest was at the addition of 4.5% nanocalcium. The water content of flavor from this swimming crab boiled water was still relatively high, since the raw material in the form of boiled water was not thickened, so that drying was not optimal. Besides the addition of maltodextrin which was less than 20%, so that the water content was still high. In liquid raw materials, dextrin higher than 20% was needed to reduce the water content below 10%. The flavor of tuna boiled water using maltodextrin 20-26% produced a flavor with a water content of 4-7% [17]. The water content of the swimming crab’s shell showed a lower water content of 3.48% -4.05% [5] and 6% [6] because the raw material used was an a solid material.

The addition of nanocalcium significantly affected the protein content of flavor from the swimming crab boiled water. The highest level of protein was in the control (without nanocalcium) with the addition of 15% maltodextrin and 0% nanocalcium. Aside from being filler, maltodextrin also has a function as a coating. When maltodextrin was increased, the protein material which was coated by maltodextrin increased, so that the protein content in the flavor also increased because in this case the amount of raw material added was the same. In contrast to the flavor that was using only maltodextrin as filler, that the protein content of the flavor was reduced as comparison to the raw materials. The protein content of flavor from lemi’s swimming crab was decreased with the addition of dextrin with a protein

![Figure 2](image-url)
content of 43.07% -34.12% [7]. The protein flavor content of this study was lower than [7] because the raw material was the remaining boiled water, so that the protein that was dissolved into the water was lower because of the swimming crab indirectly brushed boiled water. Flavor from tuna boiled water contained higher protein because a lot of protein was dissolved during the boiling process [17].

The addition of nanocalcium increased the calcium content of the flavor from swimming crab. The addition of nanocalcium was from the bones of tilapia with calcium content which were quite high at 35.016%. Thus, the addition of nanocalcium with a higher amount increased the calcium content in the flavor. Calcium content in this study was higher than the results of the study of [5] which showed that calcium content of swimming crab shell was 26.82%. The high calcium in this study was due to the addition of nanocalcium from fish bones containing higher calcium than swimming crab shells. [18] reported the calcium content of fish bones reaching 13.3-23.3%, while the swimming crab calcium was around 2.028% [19].

The addition of nanocalcium from tilapia bones significantly affected the glutamate acid content of flavor from the swimming crab boiled water (P<0.05). Glutamic acid content increased along with the enhancement of the amount of nanocalcium in the swimming crab flavor (Table 2). The highest glutamate acid content was in flavors which added by 4.5% nanocalcium and the lowest was in flavor control (without the addition of nanocalcium). This was because fish bones contained high glutamate acid. Amino acids in fish bones were dominated by glycine and glutamate acid as reported by[18]. Further [20] reported that arginine, glycine, alanine, glutamate, IMP and AMP had a role in giving strong flavor to swimming crab meat. However, the glutamate acid content of the flavor from the remaining swimming crab boiled water was lower than the flavor from lemi of swimming crab. [7] showed that glutamate acid in flavor from lemi of swimming crab reached 48-66%. That was because the raw material used was a solid material with high levels of glutamate acid which was 48.65%.

The increase in the amount of nanocalcium that added to the flavor had a significant effect (P<0.05) on the Aw value in the flavor. The highest Aw was in the control, whereas the flavor with the addition of calcium showed aw value that was not significantly different (P>0.05). Aw value and water content had a role in chemical reactions rate and the growth of microorganisms in food [21]. Water content and water activity in food will decrease with the drying process. Aw in flavor from swimming crab boiled water showed the value of Aw was safe from spoilage by microorganisms both bacteria, fungi and mold because the value was lower than 0.6. According to [22], the growth of microorganisms (bacteria, fungi, and mold) in food can be inhibited with Aw values of less than 0.6.

3.4. Sensory Characteristics (Hedonic) of Nanocalcium from Tilapia Bones

![Hedonic Value of Swimming Crab Flavor](image)

Figure 3. Hedonic value of swimming crab flavor with different nanocalcium concentrations.

The level of preference for swimming crab flavor was seen from the smell, taste, color and texture. The total value of the hedonic of the flavor with the addition of 0% to 4.5% calcium indicated that the sample was favored by panelists (7.08-7.31), but the highest was on flavor with the addition of
4.5% (Figure 3). This was probably due to the glutamate acid content of the flavor with the addition of 4.5% nanocalcium was the highest compared to the others. Glutamic acid gave a savory flavor to the flavor, which was preferred by panelists.

4. Conclusions

The results showed that the addition of fillers in the form of nanocalcium and maltodextrin significantly affected the physical, chemical and sensory of flavor characteristics from swimming crab stewed water. The best treatment in this study showed the addition of 3% nanocalium and 12% maltodextrin gave the highest solubility characteristics (98.28%); with a high yield (23.45%); low water content (11.46%); high protein (7.2%); high calcium (50.48%); high glutamate (23.53%); The lowest aw (0.52) and hedonic value was 7.08 that showed it was favored by panelists.

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