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Sensory and Chemical Properties of Long Jawed Mackerel *(Rastrelliger kanagurta* L.) Fish Balls with Addition of Canna *(Canna edulis* Kerr.) Starch Concentration as a Filler

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Abstract. The aim of this study was to investigated the characteristic of chemical and sensory properties of Long Jawed Mackerel fish balls which is uses canna starch concentration as a filler. The design of the research used Completely Randomized Block Design with one factor, canna starch concentration which is consist of 7 level concentration (control with tapioca starch, 5%, 10%, 15%, 20%, 25%, and 30%). The sensory parameters were observed scoring methods (color, scent, flavor, and texture), and hedonic methods (overall acceptance) by 20 panelists. Chemical parameters were observed a score of moisture content, and ash content. The best fish balls with concentration of canna starch based on sensory, moisture, and ash content were continued observed a score of protein, fat, and carbohydrate content. The result showed that the usage of canna starch as a filler affected the sensory and chemical characteristics of long jawed mackerel fish balls. Fish balls with 5% canna starch concentration was the best concentration as a filler which has sensory characteristic grayish white color, fish specific scent, fish specific taste, chewy texture, overall acceptance likes, and has 73,70% moisture content, 1,46% ash content, 16,51% protein content, 4,66% fat content, 3,67% carbohydrate content.

1. Introduction

Meatballs are processed products made from meat that has been pulverized, shaped into circles and subjected to a boiling process. In general, the term meatball is followed by the name of the type of meat as its raw material, such as beef meatballs, chicken meatballs, and fish balls. Currently, meatballs that are commonly known by the general public are meatballs derived from beef and chicken. The use of fish meat as a raw material for making meatballs is relatively rare [1], even though fish is one of the foodstuffs with low prices and has a higher protein absorption compared to other animal products such as beef and chicken. According to Wahyudi and Maharani (2017) [2], fish has the largest protein composition in the group of other animal protein sources, which is around 57.2%, while beef has a protein content of 26%, and chicken meat has a protein content of 18.80% [3]. The characteristics of fish with a high moisture content of around 80% make the fish susceptible to decay. Therefore, a

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processing process is needed to add value both in terms of taste, aroma, texture, shape and nutrition [4]. One of the processed fish products is fish balls. One of the fish that can be used for making fish balls is long jawed mackerel fish *(Rastrelliger kanagurta L.).*

Long jawed mackerel fish is a pelagic fish that is mostly found in the peak season from March to June which is spread throughout Indonesian waters. Based on data by Badan Pusat Statistik Indonesia in 2015 [5], the catch of mackerel is one of the largest catch commodities, amounting to 16,895 tons. Long jawed mackerel fish has a higher nutritional content than other fish in terms of protein, energy, fat, vitamins and minerals [6]. The superior nutritional content contained in mackerel is omega 3 which consists of EPA *(Eicosa Pentaenoic Acid)* and DHA *(Deicosa Hexaenoic Acid)*. The use of long jawed mackerel is currently only consumed as a side dish that is cooked as a whole, such as fried, baked, or gravy, so there needs to be other optimal uses to make processed products that are practical and liked by all people, one of which is the use of large sized mackerel to be processed, become fishballs. Components or constituent materials in the manufacture of fish balls will affect the quality of meatballs, one of which is filler. Fish meatballs have a smoother texture and distinctive aroma compared to meatballs made from livestock. One of the requirements for fish raw materials in making meatballs is fish with high protein so that it can increase the gel strength of the meatball dough, but mackerel has a red flesh color and the presence of sarcoplasmic protein that can affect gel formation [7]. This will affect the texture of the fish balls and the color of the fish balls will darken so that they are less liked by consumers. Improvement of the texture and color of fish balls can be done through the selection of fillers.

The filler that is commonly used in making fish balls is tubers that contain starch so that the meatball texture becomes compact and chewy, one of the common ones is tapioca starch. However, there are 30 other types of tubers that can be consumed and spread in Indonesia, one of which is canna tubers. Utilization of local food sources, one of which is canna starch as a substitute for tapioca starch, is carried out to support food diversification programs and increase food security based on local tubers [8]. Ganyong (Canna edulis Ker.) is a group of clumped herbs and belongs to the tubers group. According to Pangesthi (2009) [9], canna plants have advantages over other tuber plants, namely the number of edible tubers is 68%, with a crude fiber content of 0.04% in starch. Canna tubers can be processed to produce canna starch seen from the high starch content in the tubers, which is 40.18% to 71.08% [10]. High levels of amylose and amylopectin play a role in gel formation and viscoelastic properties in the texture of meatballs [11], so that in this study the use of various concentrations of canna starch as fish ball filler is expected to be able to meet consumer sensory values and have a good chemical composition.

2. Material and Methods

2.1 Materials

The main raw material used in this study was Long Jawed Mackerel Fish *(Rastrelliger kanagurta L.)* which was obtained from the Gudang Lelang Market Fish Auction Center, Teluk Betung, Lampung (Indonesia). The additional ingredients used in the study were commercial canna starch as a filler with the brand Lingkar Organik Canna edulis variety originating from the Sleman, Yogyakarta (Indonesia), shallots, garlic, granulated sugar, fine salt, pepper, and ice water were purchased on Gudang Lelang Market, Lampung (Indonesia).

2.2 Preparation of Long Jawed Mackerel Fish Balls

Preparation of make fish balls begins with the process of making mashed meat long jawed mackerel fish. First, the fresh mackerel was weeded and separated from the bones and skin (fillet) manually and weighed as much as 250 grams. Then the mackerel meat is cut and mashed. The process of refining mackerel meat using a food processor with the addition of 5.5% (w/v) ice water and 2.6% (w/w) salt to obtain mashed meat. The crushed mackerel meat was weighed according to the treatment and added canna starch according to the concentration of treatment, namely 5%, 10%, 15%, 20%, 25%, and 30% and tapioca starch as a control treatment was 13% (w/w), sugar 0.17% (w/w), spices such as shallots 2.25% (w/w), garlic 2.6% (w/w) and pepper 0.35% (w/w) which has been mashed into the dough, then the dough is stirred until well blended. Furthermore, the dough is molded to form spheres or balls with

a diameter of 2 cm. The fish ball dough is then put into water that has been heated at 85ºC for 15 minutes to 100ºC until the fish balls float within 5 minutes, resulting in a complete gelatinization process, then the fish balls are drained and cooled at room temperature for 15 minutes.

2.3 Analytical Methods

The treatments were arranged in a Completely Randomized Block Design with 4 replications consisting of one factor, namely the concentration of canna starch. The concentration of canna starch consisted of 7 levels, namely P0 (control with tapioca starch), P1 (5%), P2 (10%), P3 (15%), P4 (20%), P5 (25%), and P6 (30%). The concentration of canna starch used was obtained by formulating fish meat in the manufacture of fish balls. The similarity of variance was tested by the Bartlett test and the additional data was tested by the Tuckey test. The data were analyzed by means of variance to get an estimator of the variance of the error and a significance test to determine the effect of treatment. Differences between treatments were further analyzed using the Honestly Significant Difference (HSD) test at the 5% level. Sensory evaluation used twenty semi-trained panelists for the scoring method for the parameters of colour, scent, taste, and texture, and twenty untrained panelists for the hedonic method to determine the panelist level of preference for the product. The moisture and ash content were determined based to the AOAC methods by drying the samples using a convection drying oven at 105°C to achieve a constant weight, and burning the samples at 600°C. Protein content was determined according to the Kjeldahl method, Fat content was analyzed using soxhlet extraction method and carbohydrate using *by difference* method.

3. Results and Discussion

3.1 Sensory Properties of Long Jawed Mackerel Fish Balls

Sensory properties of long jawed mackerel fish balls were determined using a scoring method for a colour, scent, flavour, and texture, then a hedonic method for consumer acceptance test.

3.1.1 Colour

Sensory properties of colour parameter were determined using a scoring method. The score in **Table 1** presented the score that given by panelist on each level filler concentration fish balls. The scale consists five labelled categories which range from ‘not grey’ to ‘white’ which the score levels are 1= not grey; 2= grey; 3= slightly greyish white; 4= grey-white; 5= white. The score of colour parameter of long jawed mackerel fish balls increased significantly different (P<0,05) due to the difference concentration of canna starch as a filler. The score obtained on the color parameter through the scoring test ranges from 2.48–3.84 (grey–greyish white).

Table 1. Colour Parameter of Sensory Properties Long Jawed Mackerel Fish Balls

Canna Starch Concentration (%)	Colour Middle Value (HSD 5% = 0,996)
0% (control, with tapioca starch)	3,01[a]
5%	3,84[a]
10%	3,25[a]
15%	3,08[a]
20%	2,91[ab]
25%	2,59[b]
30%	2,48[b]

*Different notations in the same column show a significant difference at α = 0,05
Formula of canna starch as a filler based on the percentage of total fish meat portion in fish balls dough formula.

Based on **Table 1**, The highest score on the color parameter was found in treatment 5% of 3.84 (gray white), while the lowest score was found in treatment 30% of 2.48 (gray), 25% of 2.59 (gray), and P4 of 2.91 (slightly grayish white). This indicates that different concentrations of canna starch can affect the colour parameters of long jawed mackerel fish balls. According to Azizah and Rahayu (2018) [1],

that the higher the concentration of canna starch used in the manufacture of mackerel fish balls, the color of the resulting product is brownish white caused by the Maillard reaction during the boiling process of mackerel fish balls. Based on its characteristics, canna starch has a characteristic that is almost similar to tapioca flour, namely white, but darker canna starch tends to be gray due to the enzymatic browning process during the canna starch production process [12],[13]. The color produced is influenced by the color of the canna starch as a filler, which is grayish white due to the enzymatic browning process during the production process through the oxidation of polyphenol compounds by the polyphenolase enzyme which is naturally found in canna tubers. The phenol content in canna tubers is around 17.7–46.9 ppm [13]. In addition, there is a Maillard reaction during the boiling process which can cause the product to become dark in color. The Maillard reaction that occurs is an interaction between proteins derived from fish meat as a source of amino acids with reducing sugars contained in starch as product fillers during the cooking process, resulting in a dark product color due to the formation of a melanoidin pigment complex during the Maillard reaction. The formation of the dark color of fish balls is also influenced by the characteristics of long jawed mackerel meat which has a red meat color due to the high content of fat and sarcoplasmic protein [14]. The presence of sarcoplasmic protein in the structure of long jawed mackerel meat has an influence on the color of the resulting product, which is gray due to the content of myoglobin which is a pigment in giving red color to fish meat [15].

3.1.2 Scent

Sensory properties of scent parameter were determined using a scoring method. The score in **Table 2** presented the score that given by panelist on each level filler concentration fish balls. The scale consists five labelled categories which range from 'very not specific fish' to 'very specific fish' which the score levels are 1= very not specific fish; 2= not specific fish; 3= slightly specific fish; 4= specific fish; 5= very specific fish. The score of scent parameter of long jawed mackerel fish balls significantly different ($P<0,05$) due to the difference concentration of canna starch as a filler. The score obtained on the scent parameter through the scoring test ranges from 3.51–4.09 (special fish scent).

Table 2. Scent Parameter of Sensory Properties Long Jawed Mackerel Fish Balls

Canna Starch Concentration (%)	Scent Middle Value (HSD 5% = 0,324)
0% (control, with tapioca starch)	$3,51^{c}$
5%	$4,09^{a}$
10%	$3,88^{ab}$
15%	$3,74^{bc}$
20%	$3,68^{bc}$
25%	$3,59^{bc}$
30%	$3,56^{bc}$

*Different notations in the same column show a significant difference at $\alpha = 0,05$
Formula of canna starch as a filler based on the percentage of total fish meat portion in fish balls dough formula.

Based on **Table 2,** The addition of canna starch resulted in treatment 5% getting the highest score 4.09 (specific fish scent), while treatment 30% with the highest concentration of canna starch got the lowest score 3,56 (specific fish scent). The decreased score can be caused canna tubers contain 0.18% soluble phenolics, 0.23% soluble tannins and 0.78% insoluble condensed tannins. The presence of phenolic compounds contributes to the sensory end product, one of which is aroma, because it has a group of aromatic compounds that can cause the formation of a distinctive aroma. The tannin content contained in canna tubers has a hydroxyl group and other groups such as carboxyl which are able to form complex bonds with proteins and other macromolecular groups [16]. This causes the addition of the concentration of canna starch, the distinctive aroma of fish obtained is reduced, due to the formation of complex bonds between tannins and fish proteins as aroma-forming. In addition, according to Silaban et al. (2017) [17], the addition of various spices that have a distinctive aroma such as shallots, garlic,

and pepper can reduce the distinctive aroma of fish, but at the highest concentration of canna starch, which is 30%, the aroma of fish balls is still dominated by the distinctive aroma of fish.

3.1.3 Flavour

Sensory properties of flavour parameter were determined using a scoring method. The score in **Table 3** presented the score that given by panelist on each level filler concentration fish balls. The scale consists five labelled categories which range from 'very not specific fish' to 'very specific fish' which the score levels are 1= very not specific fish; 2= not specific fish; 3= slightly specific fish; 4= specific fish; 5= very specific fish. The score of flavour parameter of long jawed mackerel fish balls significantly different (P<0,05) due to the difference concentration of canna starch as a filler. The score obtained on the flavour parameter through the scoring test ranges from 3.49–4.03 (slightly specific fish- specific fish).

Table 3. Flavour Parameter of Sensory Properties Long Jawed Mackerel Fish Balls

Canna Starch Concentration (%)	Flavour Middle Value (HSD 5% = 0,470)
0% (control, with tapioca starch)	3,59[ab]
5%	4,03[a]
10%	3,80[ab]
15%	3,70[ab]
20%	3,61[ab]
25%	3,53[b]
30%	3,49[b]

*Different notations in the same column show a significant difference at $\alpha = 0,05$
Formula of canna starch as a filler based on the percentage of total fish meat portion in fish balls dough formula.

According to the **Table 3,** the highest score on the taste parameter was found in treatment 5% of 4.03 (specific fish), while the lowest score was found in treatment of 25% of 3.53 (slightly fish-specific), and 30% of 3.49 (slightly fish-specific). According to Zhang et al. (2011) [16], in canna tubers there are phenolic compounds with the largest percentage of tannins, 0.23% soluble tannins and 0.78% insoluble condensed tannins which can affect the taste of canna starch. Tannins as phenolic compounds play a role in flavor formation so that they contribute a slightly astringent taste to canna starch. The presence of hydroxyl and carboxyl groups in tannins causes a complex bond between tannins and proteins, so that the addition of high concentrations of starch is able to cover the distinctive taste of fish formed by amino acids in fish protein. In addition, canna starch contains 0.43% fat [10], so that according to Fitriyani et al. (2017) [18], starch derived from tubers can produce an unpleasant taste due to the presence of fat content that undergoes oxidation and produces hydroperoxide compounds that break down into aldehydes and ketones, thus disturbing the resulting taste.

3.1.4 Texture

Sensory properties of texture parameter were determined using a scoring method. The score in **Table 4** presented the score that given by panelist on each level filler concentration fish balls. The scale consists five labelled categories which range from 'very tender' to 'very chewy' which the score levels are 1= very tender; 2= tender; 3= slightly chewy; 4= chewy; 5= very chewy. The score of texture parameter of long jawed mackerel fish balls significantly different (P<0,05) due to the difference concentration of canna starch as a filler. The score obtained on the texture parameter through the scoring test ranges from 3.66–4.10 (chewy).

Table 4. Texture Parameter of Sensory Properties Long Jawed Mackerel Fish Balls

Canna Starch Concentration (%)	Texture Middle Value (HSD 5% = 0,311)
0% (control, with tapioca starch)	3,66[a]
5%	3,78[a]
10%	3,81[ab]
15%	3,83[ab]
20%	3,86[ab]
25%	3,93[ab]
30%	4,10[b]

*Different notations in the same column show a significant difference at α = 0,05
Formula of canna starch as a filler based on the percentage of total fish meat portion in fish balls dough formula.

The formation of fish ball texture is influenced by the gelatinization process by starch used as a filler. Gelatinization of starch occurs due to the development of starch granules through heating temperatures, starting with the breaking of hydrogen bonds and diffusion of amylose and amylopectin components so that the starch granules are able to hold water out of the starch granules, and make water enter the starch granules which are able to form a rubbery texture. In addition, the formation of texture is influenced by the role of amylose and amylopectin during gelatinization [19]. Based on the research of Santoso et al. (2015) [20], canna starch has amylose content of 17.59% and amylopectin content of 82.41% with a starch granule size of 20–50 µm, when compared to tapioca which has amylose content of 17% and amylopectin of 83% with starch granule size is 5-35 µm [21], then canna starch has a higher amylose content and a larger granule size so that more water can enter the starch granules so as to form a chewy texture. The role of amylose in food products is to provide strength or cohesiveness to the gel, which plays a role in the level of product hardness, while amylopectin plays a role in the formation of the level of viscoelastic or elasticity in a food product [22],[23]. In addition, the formation of a chewy texture is also caused by the formation of fish meat protein gel through heating treatment during the meatball making process, resulting in denaturation which causes the aggregated protein to form a three-dimensional structure. This causes the reactive groups of proteins to open and form bonds, so that they are able to hold liquid and form a gel that produces a chewy fish ball texture [24].

3.1.5 Overall Acceptance

Overall acceptance were determined using a hedonic method. The score in **Table 5** presented the score that given by panelist on each level filler concentration fish balls. The scale consists five labelled categories which range from 'very dislike' to 'very like' which the score levels are 1= very dislike; 2= dislike; 3= slightly like; 4= like; 5= very like. The score of overall acceptance of long jawed mackerel fish balls significantly different (P<0,05) due to the difference concentration of canna starch as a filler. The score obtained on the scent parameter through the scoring test ranges from 3.10–4.05 (slightly like-like).

Table 5. Overall Acceptance of Sensory Properties Long Jawed Mackerel Fish Balls

Canna Starch Concentration (%)	Overall Acceptance Middle Value (HSD 5% = 0,250)
0% (control, with tapioca starch)	3,66[b]
5%	4,05[a]
10%	3,41[bc]
15%	3,33[cd]
20%	3,28[cd]
25%	3,26[cd]
30%	3,10[d]

*Different notations in the same column show a significant difference at α = 0,05
Formula of canna starch as a filler based on the percentage of total fish meat portion in fish balls dough formula.

According to Winarno (2002) [25], a food with high nutrition, delicious, and has a very good texture, will not be eaten if the color and aroma give the impression that deviates from the original product. A distinctive aroma can be felt by the sense of smell depending on the ingredients used in the product, while the taste can come from the nature of the material or because of other ingredients used during the processing process. The use of a variety of food ingredients will create a complete taste. The overall acceptance of the product by the panelists can be influenced by both social and geographical aspects. Based on the things that have been explained, that of all the parameters have an influence on the overall acceptance of a food product.

3.2 Chemical Properties Long Jawed Mackerel Fish Balls

Chemical analysis in this study included moisture content and ash content based on the AOAC method, and for the best treatment, it was continued by testing protein content using the Kjeldahl method, fat using the Soxhlet method, and carbohydrates using the by difference method.

3.2.1 Moisture Content

Moisture content were determined using AOAC methods by drying the samples using a convection drying oven at 105°C to achieve a constant weight. Moisture content of long jawed mackerel fish balls are shown in **Table 6.** The score moisture content of long jawed mackerel fish balls increased significantly different (P<0,05) due to the difference concentration of canna starch as a filler. The highest value on the moisture content parameter is found in treatment 5% of 73.70%, 10% of 70.43%, and 15% of 69.66%, while the lowest value is found in control treatment with tapioca starch of 66.27%, 20% by 65.03%, 25% by 64.90%, and 30% by 64.77%.

Table 6. Moisture Content of Long Jawed Mackerel Fish Balls

Canna Starch Concentration (%)	Moisture Content Middle Value (HSD 5% = 4,198)
0% (control, with tapioca starch)	66,27^{bc}
5%	73,70^{a}
10%	70,43^{ab}
15%	69,66^{ab}
20%	65,03^{c}
25%	64,90^{c}
30%	64,77^{c}

*Different notations in the same column show a significant difference at $\alpha = 0,05$

Formula of canna starch as a filler based on the percentage of total fish meat portion in fish balls dough formula.

The moisture content of fish balls can be affected by gelatinization of fish balls starch. Gelatinization is the process of breaking down the granule form due to heat. The gelatinization temperature of canna starch ranges from 71.9°C to 74.8°C [26], so that the starch granule molecules expand and then absorb water, and are irreversible during the meatball boiling process. In the gelatinization process, starch granules expand due to the breaking of hydrogen bonds which allows water to enter the starch granules, can hold water out, and increase the moisture content of the product. Materials containing starch tend to be hydrophilic, because the number of hydrophilic groups in the starch molecule is very large, so the ability to absorb water is also large so that the water in the starch grains cannot move freely [19]. The moisture content and the size of the starch granules can also affect the moisture content of the fish balls. The higher the moisture content and the larger the size of the granules in starch, the easier the starch is to be gelatinized so that it is easier to absorb water. The moisture content of canna starch ranges from 10.09%-10.79% with a starch granule size of 20-50 µm which is higher than tapioca moisture content of 9% with a starch granule size of 5-35 µm [10],[20],[21]. The presence of protein in a material is also hydrophilic so that it can increase the water holding capacity and interfere with the starch gelatinization process by binding to the hydrophilic groups of starch. In addition, the interaction between protein and the addition of fillers can reduce the percentage of moisture content in fish balls. This decrease was caused by an increase in the bonding of starch granules with protein, so that water could not be absorbed optimally due to hydrogen bonds that should have been used to bind water. gelatinization process [27].

3.2.2 Ash Content

Ash content were determined using AOAC methods by burning the samples on 600ºC. Ash content of long jawed mackerel fish balls are shown in **Table 7.** The score ash content of long jawed mackerel fish balls increased significantly different (P<0,05) due to the difference concentration of canna starch as a filler. The highest value on the ash content parameter is found in treatment 30% by 3,93%, while the lowest value is found in 5% by 1,46%.

Table 7. Ash Content of Long Jawed Mackerel Fish Balls

Canna Starch Concentration (%)	Ash Content Middle Value (HSD 5% = 1,002)
0% (control, with tapioca starch)	$3,03^{bcd}$
5%	$1,46^{a}$
10%	$2,71^{bc}$
15%	$2,88^{bc}$
20%	$3,17^{bcd}$
25%	$3,69^{bcd}$
30%	$3,93^{d}$

*Different notations in the same column show a significant difference at $\alpha = 0,05$
Formula of canna starch as a filler based on the percentage of total fish meat portion in fish balls dough formula.

Ash content is related to the minerals of a material. The ash content in a food ingredient indicates the presence of inorganic mineral content in the food material [28]. Long Jawed Mackerel fish balls contain ash which mostly comes from canna starch and fish meat. According to Purwaningsih et al. (2013) [10], the ash content of pure canna starch is 2.47%. The main mineral content contained in canna starch is phosphate, magnesium, potassium, iron, and vitamins A and B1. Canna starch contains phosphate as the main mineral as much as 15.74 ppm. The phosphates contained in starch are generally in the form of phosphate monoesters that are bonded to amylopectin molecules at C-2, C-3, and C-6 atoms [20].

3.3 Determination the Best Formula of Long Jawed Mackerel Fish Balls

Determination of the best treatment for mackerel meatballs in this study was based on the results of the BNJ test at a level of 5% on the sensory test, namely the scoring test which included the parameters of color, aroma, taste, texture, and hedonic test with overall acceptance parameters, and chemical test which included moisture content test. and ash content. The results of testing the moisture content and ash content were compared with SNI 7226:2014 [29] regarding the quality standard of fish balls, so that the best fish ball treatment or formula was 5%. The best treatment was then tested for protein, fat and carbohydrates.

3.3.1 Chemical Properties of the Long Jawed Mackerel Best Formula Fish Balls

The best formula long jawed mackerel fish balls were analyzed the chemical composition involve moisture content, ash content, protein content, fat content, and carbohydrate content in order to determine the chemical characteristic of 5% canna starch as a filler. Chemical properties of 5% canna starch as a long jawed mackerel fish balls filler are shown in **Table 8.**

Table 8. Chemical Properties of Best Formula Long Jawed Mackerel Fish Balls

Canna Starch Concentration (5 %)	Score (%)
Moisture Content (%)	73,70%
Ash Content (%)	1,46%
Protein (%)	16,51%
Fat (%)	4,66%
Carbohydrate (%)	3,67%

The value of moisture content is due, meatballs are a food product containing starch, a product containing starch tends to be hydrophilic, because the number of hydrophilic groups in the starch molecule is quite large, the ability to absorb water is also large which causes water to be in the starch grains and not can move freely. The component in starch that has a major role in water absorption is amylose which has the ability to absorb water and expands higher because amylose has the ability to form hydrogen bonds that are greater than amylopectin [19]. In addition, the protein contained in a material has functional properties as a binder, so it requires a large amount of water in the reaction process. This is because on the surface structure of the protein there are two groups, namely hydrophobic and hydrophilic, so that the hydrophilic group tends to bind water molecules [30].

Measurement of ash content aims to determine the amount of mineral content contained in a material. The value of ash content obtained in the manufacture of long jawed mackerel fish balls is influenced by the ash content and mineral content contained in the material. According to Purwaningsih et al. (2013) [10], the ash content of pure canna starch is 2.47%. Meanwhile, fresh long jawed mackerel contained 85.41 RE IU/g vitamin A, 0.47 g/g vitamin B12, 9.07 mg/g sodium, 10.83 g/mg potassium, 0.88 g/mg calcium , 0.07 g/mg iron, and 0.03 g/mg zinc (Nurilmala et al., 2015). The ash content obtained by the best long jawed mackerel fish balls with the addition of 5% canna starch concentration of 1.46% which already meets SNI 7226:2014 is a maximum of 2%. In addition, the source of ash in fish balls can also be caused by the use of spices and salt. According to Hakim (2015) [32], pepper contains vitamins A, C, and B, various minerals such as potassium, calcium, zinc, manganese, iron, and magnesium. Shallots and garlic contain minerals such as sulfur, iron, chlorine, phosphorus, potassium, calcium, and magnesium as well as vitamins A, B1 (thiamin), B2 (riboflavin), B3 (niacin). The increase in salt in the product will increase the ash content of the product because the salt consists of Na^+ and Cl^- and can be a precursor of ash which is an inorganic residue from the combustion of organic materials [33].

The best protein content in long jawed mackerel fish balls with the addition of 5% canna starch concentration of 16.51%. The protein content in mackerel meatballs has met the requirements of SNI 7226:2014 regarding the quality of fish balls with a minimum protein content of 7%. The protein content in a product is influenced by the protein content in the ingredients used. The protein content of canna starch is only 2.34%. This is because canna starch does not contain gluten, so it has a low protein content, compared to 11% wheat flour [10],[34]. In addition, the main protein content is influenced by long jawed mackerel meat as the main raw material for making fish balls, with a protein content of 25.32% [35].

The fat content in long jawed mackerel fish balls is obtained from the ingredients used in making fish balls. According to Purwaningsih et al. (2013) [10], the fat content in canna starch is very low, only 0.43%. Meanwhile, fresh mackerel fillet meat contains 7.01% fat content [36]. Long jawed mackerel is a marine fish that has a high fat content, the dominant fatty acids in long jawed mackerel are omega-3 fatty acids, namely Eicosa Pentaenoic Acid (EPA) and Deicosa Hexaeonic Acid (DHA). According to Latupeirissa and Rumahlatu (2016) [37], the EPA fatty acid content in fresh long jawed mackerel is 5.20%, and the DHA fatty acid content in fresh long jawed mackerel is 17.87%.

Carbohydrate content was obtained from the calculation by difference after knowing the amount of moisture content, ash content, protein content, and fat of the best treatment fish balls. The best treatment of fish balls with the addition of 5% canna starch resulted in a carbohydrate content of 3.67%. According to Sutanto (2018) [38], the presence of a dissolved fraction with water, namely the amylose component in starch, will affect the moisture content of the material due to its water binding properties, so that the greater the moisture content in the material, causing more dissolved starch which reduces the carbohydrate content in the product. According to Santoso et al. (2015) [20], canna starch has amylose content of 17.59% and amylopectin content of 82.41%, while according to Sinaga (2020) [36], fresh long jawed mackerel meat contains only 0.01% carbohydrates.

4. Conclusions

Based on the research conducted, it was concluded that long jawed mackerel fish balls with the addition of canna starch were best at 5% canna starch concentration as filler treatment with a color score of 3.84 (greyish white), aroma score of 4.09 (specific fish), taste score of 4.03 (specific fish), texture score 3.78 (chewy), overall acceptance score 4.05 (like), water content 73.70%, ash content 1.46%, protein content 16.51%, fat content 4.66%, and carbohydrate content of 3.67%.

5. References

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