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Effect of Duck Meat Maceration in Coconut Shell Liquid Smoke on the Quality of Duck Meat Sausage

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study aims to determine the effect of maceration of coconut shell liquid smoke in increasing the preference value of panelists and the quality of duck meat sausages both physically and chemically. This study was conducted in January 2023 at the Meat Processing Laboratory, Animal Product Technology Section, Faculty of Animal Science, Brawijaya University. The material used was duck meat sausage. This study used an experimental method with a completely randomized design consisting of 5 treatments and 4 replications. The results of the analysis showed that maceration of coconut shell liquid smoke produced no significant effect (P>0.05) on carbohydrates, protein content, ash content, fat content, moisture content, cooking loss, pH, and tenderness but had a very significant effect (P< 0.01) on the value of water holding capacity and organoleptic value. From this study, it could be inferred that maceration of coconut shell liquid smoke could help in reducing the value of cooking loss, moisture content, fat content, carbohydrates, and pH as well as increase the value of ash content, protein content, and water holding capacity.

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1. INTRODUCTION

Duck meat is one of the rarely processed poultry, yet it has the advantage of a complex taste due to the fat content which could affect the taste of duck meat. The complex taste of duck meat also has drawbacks, namely a thick fishy odor compared to other poultry and a tougher meat texture. Processing duck meat into sausages is one of the methods to increase the value of the meat. Sausage is a processed meat product with a chewy, soft texture and good taste [1] so sausage is a processed meat product that is quite popular among Indonesian citizens.

Liquid smoke is the result of condensation from wood pyrolysis which contains a large number of compounds such as lignin, hemicellulose, and cellulose which go through a high-temperature combustion process in a closed room or in a vacuum that consists of pipes for distributing smoke, pyrolysis tubes, tar catchers, liquid smoke containers and condensers [2]. Coconut shell liquid smoke has a brownish color and a distinctive odor. Therefore, it could be used as a flavoring ingredient in food. The use of coconut shell liquid smoke as a substitute for direct smoking (roasting over a wood fire) however still has drawbacks, namely the desired concentration and taste of smoke is difficult to adjust, therefore the resulting product will not be the same as one another because the best temperature and time cannot be maintained. The use of coconut shell liquid smoke is expected to improve the taste and reduce the distinctive odor of duck meat in sausages, hence it can attract consumer interest. This distinctive odor of ducks is caused by the feed consumed by ducks has a high content of fat and protein which is expected to disappear along with the maceration process of coconut shell liquid smoke on duck meat in making sausages [3].

2. RESEARCH METHODS

2.1 Tools and Materials

The tools used in the study were cutting boards, knives, 100 ml beaker glass (Pyrex), 1 ml dropper pipettes, gas stoves, boilers, tissues, spoons, sample containers, stirrers, analytical scales, measuring cups (Herma), foodscan, pH meter (Mediatech), furnace, and waterbath with the materials used are coconut shell liquid smoke, duck meat, STTP, egg yolk, lime (citrus aurantiifolia), pepper, oil, tapioca flour, ice cubes, garlic, nutmeg, salt, sugar, distilled water, whatman paper no.42 9 cm in diameter, 4 and 7 buffer solutions.

2.1.1 Research methods

The method used in this study uses a Completely Randomized Design. Maceration treatment of coconut shell liquid smoke was carried out with P1 (10 minutes), P2 (20 minutes), P3 (30 minutes), P4 (40 minutes), and P5 (50 minutes), and each treatment was repeated 4 times to produce 20 samples. Samples were conducted in the laboratory, then to be analyzed further for the physical, chemical, and organoleptic properties.

2.1.2 Research procedure

1. The duck was separated from its skin and bone, and then washed under running water
2. The duck meat was sliced into fillets and then put in the vacuum marinator with the aim of marinating with a concentration of 6% lime extract
3. Marinated duck meat was washed under running water and then macerated into 1% coconut shell liquid smoke for a different length of time according to the treatment
   - P1: 10 minutes
   - P2: 20 minutes
   - P3: 30 minutes
   - P4: 40 minutes
   - P5: 50 minutes
4. Duck meat, which had been soaked in coconut shell liquid smoke, was drained and then ground to form a dough which was then added with STPP, tapioca flour, sugar, oil, pepper, salt, garlic, nutmeg, egg yolks, and oil.
5. Sausages were cooked by boiling for 15 minutes at 60-70^{o}C and 30 minutes at 70-80^{o}C
6. Smoked duck meat sausages could be further analyzed physically, chemically, and organoleptic

2.1.3 Data analysis

Obtained data analysis from laboratory test results was then collected in Microsoft Excel for statistical analysis. Data analysis on the effect of maceration of coconut shell liquid smoke on duck meat in sausage products which includes the value of cooking loss, water holding capacity, pH,

moisture content, ash content, protein content, ash content, fat content, carbohydrates, tenderness, and organoleptic performed was done by using Analysis of Variance. If data was found showing significant or highly significant differences, then it was followed up with Duncan's multiple range test.

3. RESULTS AND DISCUSSION

The effect of maceration of coconut shell liquid smoke with different lengths of time on the manufacture of duck meat sausages, namely the treatment of 10 minutes, 20 minutes, 30 minutes, 40 minutes, and 50 minutes with the aim of knowing the effect of maceration time of coconut shell liquid smoke on the quality of duck meat sausages in terms of pH value, tenderness, cooking loss, Water Holding Capacity (WHC), ash content, moisture content, carbohydrates by difference, protein content, fat content, organoleptic quality, and FTIR.

3.1 Effect of Different Maceration Times of Coconut Shell Liquid Smoke on the Tenderness of Duck Meat Sausages

The results of the average tenderness of duck meat sausages with different lengths of maceration of liquid smoke were presented in Table 1. The results of the analysis of variance showed that maceration of liquid smoke with different lengths of time had no significant effect (P>0.05) on the value of tenderness of duck meat sausages. The average tenderness value in Table 1 showed an increase in the tenderness value from P1 to P5. Maceration of liquid smoke at P1, which was 10 minutes long, had the highest average value, namely 5.51, with the lowest value at P2, namely 4.04 with 20 minutes of liquid smoke maceration.

The tender point of rejected ducks according to [4] had a low value. Therefore, it could increase the toughness of the meat because the structure of the meat was composed of a lot of connective tissue, the tenderness of the meat was a factor in the level of consumer preference which includes the amount of residue left when chewing and ease of chewing. Warner-Bratzler was a tool used in measuring the value of breaking power which was influenced by myofibrillar components and connective tissue components. Maceration time affected a decrease in the value of tenderness at P5 (50 minutes), although this was not significantly different from the many factors that influenced the study [5] which explained that the long storage time affected the breaking power of the meat to decrease during storage time in a period of four weeks due to the aging process where the breaking strength of the meat would decrease resulting in an increase in the value of tenderness (tenderness). In this study, with a range of 3.40-3.53, it could be classified as tender [6] because it was in the range of 3.30-5.00. The longer the maceration of coconut shell liquid smoke on duck meat sausages, the lower the tenderness value would be. Giving liquid smoke [7] could reduce the value of breaking power in meat which resulted in tender meat, liquid smoke with phenol content functions as an antioxidant. Therefore, it can prevent food spoilage by donating hydrogen, thereby reducing food damage due to oxidation by oxygen [8]. tenderness in meat is influenced by either low or high pH values in the meat itself. In this study, the lower the pH value obtained, the lower the tenderness value would be, indicating it as the tender category.

Table 1. The average value of tenderness, cooking loss, Water Holding Capacity, pH,moisture content, carbohydrates, protein content, ash content, and fat content in duck meat sausages with different lengths of maceration of coconut shell liquid smoke

Variable	Treatment				
	P1	P2	P3	P4	P5
Tenderness (N)	3.53±0.25	3.53±0.25	3.45±0.10	3.45±0.10	3.40±0.0
Cooking Loss (%)	6.69±1.27	6.62±0.21	6.58±0.31	6.61±1.48	6.55±1.62
WHC (%)	44.37^{a}±4.58	47.97^{ab}±0.51	49.17^{ab}±1.82	51.20^{bc}±1.66	51.92^{c}±1.60
pH	5.94±0.06	5.92±0.10	5.91±0.08	5.93±0.10	5.89±0.17
Moisture Content (%)	60.71±1.27	60.64±0.29	60.45±0.18	60.64±0.35	60.43±0.60
Carbohydrate (%)	5.51±1.80	4.04±0.29	5.23±0.67	4.92±1.25	4.69 ±1.35
Protein content (%)	14.57±1.10	14.79±0.21	15.02±0.19	15.25±1.77	15.26±1.99
Ash content (%)	5.81±0.22	5.85±0.26	5.90±0.30	5.96±0.09	6.07±0.13
Fat content (%)	13.68±1.33	14.68±0.52	13.41±0.62	13.24±1.34	13.18±1.25

^{a,b,c,d} *Different superscripts showed a significant effect (P < 0.05) and had very significant effect (P < 0.01)*

Table 2. The average value of texture, color, odor, and taste of duck meat sausages with different lengths of maceration times of coconut shell liquid smoke

Variable	Treatment				
	P1	P2	P3	P4	P5
Texture	2,60±3,74	2,70±3,42	2,70±4,43	2,75±2,75	2,57±3,11
Color	2,22±0,96	2,22±2,50	2,23±1,91	2,22±1,26	2,22±0,58
Odor	2,90±4,65	2,92±1,71	3,03±3,87	2,88±2,87	3,30±5,45
Taste	2,48±2,22	2,85±4,11	2,43±3,87	2,73±1,83	2,43±3,00

3.2 Effect of Different Maceration Times of Coconut Shell Liquid Smoke on Duck Sausage Cooking Loss

The results of the average value of cooking losses in duck meat sausages with different lengths of maceration of liquid smoke were presented in Table 1. The results of the analysis of variance showed that maceration of liquid smoke with different lengths of time did not have a significant effect ($P>0.05$) on the value of cooking loss of duck meat sausages. The average value of cooking losses in Table 1 showed an increase in the value of cooking losses from P1 to P5. Maceration of liquid smoke at P1, which was 10 minutes long, had the highest average value, namely 6.69, with the lowest value at P5, namely 6.55, with 50 minutes of liquid smoke maceration time. Cooking loss is a process in which the amount of water bound to the muscle fibers of the meat will affect the nutritional value of the meat, cooking loss could also be affected by the time and temperature of the cooking process [9].

In this study, the smoked duck meat sausage had no significant effect on the length of maceration, but it still endured a decrease in value. [8] the phenolic compounds in liquid smoke could bind acid ketones, esters, and aldehyde groups, it would affect the decrease in the cooking loss value because phenol would dissociate to produce anions and H+. The decreasing cooking loss was due to an increase in the value of the phenol content in the duck meat sausage, the increase in the phenol value occurred due to the longer maceration time, hence it could increase the value of the phenol content obtained from coconut shell liquid smoke. [10] a decrease in the value of cooking loss, with an increase in the concentration of used liquid smoke, would affect the yield of meat and processed meat products to increase, a decrease in the value of cooking loss was also aligned with an increase in the WHC value. The decrease in the value of cooking loss in meat implied that the nutrients and moisture loss also decreased. Therefore, with low cooking loss, good quality duck meat sausages would be produced, compared to those with high cooking loss values. The quality of meat could be affected by the value of cooking loss because the higher the value of cooking loss, the higher the risk of nutrients escaping from the muscle fibers of the meat would be [11].

3.3 Effect of Different Maceration Times of Coconut Shell Liquid Smoke on Water Holding Capacity (WHC) of Duck Meat Sausage

The results of the average value of Water Holding Capacity in duck meat sausage with different lengths of maceration time of liquid smoke were presented in Table 1. The results of the analysis of variance showed that maceration of liquid smoke with different lengths of time had a very significant effect ($P<0.01$) on the value of water holding duck meat sausage capacity. The average value of Water Holding Capacity in Table 1 showed an increase in the value of Water Holding Capacity from P1 to P5. Maceration of liquid smoke at P5, which is 10 minutes long, had the highest average value, namely 51.92, with the lowest value at P5, namely 44.37, with 50 minutes of liquid smoke maceration. Water Holding Capacity is an indicator in measuring meat in binding water in products and added water. The Water Holding Capacity of the duck meat sausage had a significant effect, as the maceration time into the coconut shell liquid smoke increased.

Liquid smoke, which is an antioxidant, can inhibit auto-oxidation in proteins. Therefore, the Water Holding Capacity value will increase because it can bind free water and fill the spaces between cells [5]. In the study, the cooking loss value of duck meat sausage also decreased as the WHC value increases, hence it gives good results. This was supported by the statement of [12] who stated that an increased value of water holding

capacity would be associated with a low value of cooking loss during the cooking process, therefore, it will produce processed products with characteristics that were chewy, good, and compact. The longer the maceration of the duck meat in the coconut shell liquid smoke, the higher the WHC value of the duck meat sausage wpuld be. The water holding capacity value would affect the texture value because [13] a hard texture was obtained from a condition when it had a dry, tight, and sticky structure due to the extreme proportion of muscles in binding water, otherwise, a tender texture was obtained from a tenuous structure also a wet and veiny texture with low water holding capacity. [13] water bind in muscles had 3 forms, namely first was chemically bound water, the second was water that rather weakly bound to water molecules in the hydrophilic group, and the third consisted of the free water molecules layer that existed between the proteins molecules. [14] Protein denaturation would only decrease the value of free water which was in the third layer with the position of free water between protein molecules while in the first and second layers would not decrease.

3.4 Effect of Different Maceration Times of Coconut Shell Liquid Smoke on the pH of Duck Meat Sausage

The results of the average pH value of duck meat sausages with different lengths of maceration of liquid smoke were presented in Table 1. The results of the analysis of variance showed that maceration of liquid smoke with different lengths of time had no significant effect (P>0.05) on the pH value of duck meat sausage. The average pH value in Table 1 showed an increase in pH values from P1 to P5. Maceration of liquid smoke at P1, which was 10 minutes long, had the highest average value, namely 5.94, with the lowest value at P5, namely 5.89, with 50 minutes of liquid smoke maceration. The degree of alkalinity in the product could be analyzed through a pH test with a pH meter. In the study, it was found that the pH value of duck meat sausages decreased but not significantly, due to the washing of the meat under running water. Therefore, it will neutralize the pH value before the grinding process.

The administration of liquid smoke with different concentrations would affect the pH of the meat because of the acidic nature of the carboxylic acids (acetic acid, butyric acid, and formic acid) in the smoke would stick to the meat, hence it will decrease, and other factors which could affect the pH value was storing because it would increase the pH value in the presence of microbes that produce H2S and NH3 [11]. Low pH conditions in the study on duck meat sausage could reduce the number of microbes in the product. The pH value decreased in the research on duck meat sausages to the length of time it took to macerate the duck meat into the liquid smoke of the coconut shell because the smoke would stick to the duck meat more. The pH of the duck meat sausages had no significant effect due to liquid smoke which was able to maintain the pH value [15]. The pH value could be affected by the value of Water Holding Capacity, tenderness, cooking loss, and juiceness [16].

3.5 Effect of Different Maceration Times of Coconut Shell Liquid Smoke on Moisture Content of Duck Meat Sausage

The results of the average moisture content in duck meat sausages with different lengths of liquid smoke maceration were presented in Table 1. The results of the analysis of variance showed that maceration of liquid smoke with different lengths of time had no significant effect (P>0.05) on the value of the moisture content of the duck meat sausages. The average value of the moisture content in Table 1 showed an increase in the value of the moisture content from P1 to P5. Maceration of liquid smoke at P1, which was 10 minutes long, had the highest average value, namely 60.71, with the lowest value at P5, namely 60.43, with 50 minutes of liquid smoke maceration. Analysis of moisture content was an important factor in a food product because the moisture content in the product would affect the texture, product appearance, and taste. Furthermore, the moisture content could also determine the level of freshness and durability of the product [17].

The results showed that the decrease in the value of the moisture content had no significant effect on the difference in the length of maceration time into the coconut shell liquid smoke. The increasingly concentrated nature of liquid smoke could remove free or binding water which would affect the texture due to differences in the structure of the meat [18]. Liquid smoke maceration treatment could reduce the value of moisture content because liquid smoke could bind free water in the process. The content of

coconut shell liquid smoke could reduce the value of the moisture content, therefore, it also helped inhibit the growth of microbes in food [19]. Phenol was a water-soluble compound with volatile and miscible properties or content that allowed it to mix [20]. The results of the value of the moisture content in duck meat sausages would decrease with the length of maceration of duck meat in coconut shell liquid smoke due to the presence of phenol compounds in liquid smoke, this was in accordance with research [21] which stated that phenol compounds in shell liquid smoke coconut, which increased in the maceration process, would give a decrease in the value of the moisture content. The moisture content value in coconut shell liquid smoked duck meat sausage met the moisture content standards set by the Indonesian National Standard (SNI 01-3820-2015) found in sausages with a maximum value of 67%.

3.6 Effect of Different Maceration Times of Coconut Shell Liquid Smoke on Carbohydrates by-Difference Duck Meat Sausage

The results of the average value of carbohydrates in duck meat sausages with different maceration durations of liquid smoke were presented in Table 1. The results of the analysis of variance showed that maceration of liquid smoke with different lengths of time had no significant effect ($P>0.05$) on the carbohydrate value of duck meat sausage. The average carbohydrate value in Table 1 showed an increase in carbohydrate values at P1 to P5. Maceration of liquid smoke at P1, which was 10 minutes long, had the highest average value, namely 5.51, with the lowest value at P2, namely 4.04 with 20 minutes of liquid smoke maceration.

One of the main sources of energy for humans and animals was carbohydrates derived from hydrogen, oxygen, and carbon compounds, carbohydrates which were the main calorie providers with the amount given in 1 gram of carbohydrates would produce 4 Kcal [22]. There was no significant effect of the administration of different lengths of maceration time on the carbohydrate value of coconut shell liquid smoked duck meat sausage, despite the fact that maceration using coconut shell liquid smoke would increase the value of carbohydrates due to the content in coconut shell liquid smoke [22], namely the presence of cellulose and lignin, which were the building blocks of carbohydrates, therefore, it will affect the increase in carbohydrate value but in this study, there was no increase or significant effect due to concentration used in different studies [22] used concentrations of liquid smoke as much as 5%, 10%, and 15%, whereas in this study only used a concentration of 1%, therefore, it did not have an effect on the carbohydrate value. The length of maceration could also affect the decrease in the value of carbohydrates due to the use of the by-difference method which was related to the values of moisture content, fat content, protein content, and ash content, hence fluctuations in these values cound affect the results of carbohydrate values in duck meat sausage products. The value of carbohydrate content in duck meat sausages was in accordance with the Indonesian National Standard (SNI 01-3820-1995) for sausages with a maximum value of 8%.

3.7 Effect of Different Maceration Times of Coconut Shell Liquid Smoke on Protein Content of Duck Meat Sausage

The results of the average value of protein content in duck meat sausage with different lengths of maceration of liquid smoke were presented in Table 1. The results of the analysis of variance showed that maceration of liquid smoke with different lengths of time had no significant effect ($P>0.05$) on the value of the protein content of duck meat sausage. The average value of protein content in Table 1 showed an increase in the value of moisture content from P1 to P5. Maceration of liquid smoke at P5, which was 50 minutes long, had the highest average value, namely 15.26, with the lowest value at P1, namely 14.57, with 10 minutes of liquid smoke maceration time. The protein content was determined using the Kjeldal method by calculating the total nitrogen present in the food. The part of the meat which was important in the process of making sausage was protein because protein could play a role in increasing the quality of the cohesiveness of sausages [23].

Factors which resulted in an increase and decrease in protein were the presence of microbial activity which could degrade protein and the content of threonine in liquid smoke, which was included in amino acids, the increase in the value of protein content in research on duck meat sausages was along with the addition of liquid smoke due to the threonine content in liquid smoke containing nitrogen [24]. Protein

degradation began with a decrease in the value of volatile bases resulting from bacterial decomposition [25]. The longer maceration of duck meat in liquid smoke could lead to an increase in the value of protein content because liquid smoke could bind free water. Another factor that caused protein levels to increase, due to clumping in protein, was reduced moisture content [26]. According to the Indonesian National Standard (SNI 01-3820-2015) regarding sausages, the protein content in sausages had a minimum value of 13%, which means that the results of the research on protein content in liquid smoked duck meat sausages met the standards given with a value range of 14.57-15.26.

3.8 Effect of Different Maceration Times of Coconut Shell Liquid Smoke on Ash Content of Duck Meat Sausage

The results of the average ash content in duck meat sausages with different lengths of liquid smoke maceration were presented in Table 1. The results of the analysis of variance showed that maceration of liquid smoke for different lengths of time had no significant effect (P>0.05) on the value of the ash content of the duck meat sausage. The average value of the ash content in Table 1 showed an increase in the value of the ash content from P1 to P5. Maceration of liquid smoke at P5, which was 50 minutes long, had the highest average value, namely 6.07, with the lowest value at P1, namely 5.81, with 10 minutes of liquid smoke maceration. Ash content was the total collection of mineral components or inorganic materials presented in a material [27]. The composition of the ash was metal oxides derived from minerals in the carbonization process which did not undergo evaporation, an increase in the ash content in the analysis of the ash content was caused by the higher temperature and the longer carbonization time [28].

The difference in the value of the ash content could be influenced by several factors, namely the value of the moisture content, the concentration of liquid smoke, and the processing temperature where if the concentration in the addition of liquid smoke increases accompanied by the processing temperature, it would increase the value of the ash content. Moreover, the value of the ash content would give an inverse value to the moisture content, where the decreased moisture content could increase the value of the ash content [29]. The treatments in the study on duck meat sausages in liquid smoke maceration with different lengths of time had no significant effect because the concentration of liquid smoke in maceration could not increase the total value of minerals present in the product [30]. In the study of duck meat sausages with liquid smoke maceration gave an increased value due to the length of maceration which increased the value of the ash content because, during the time of maceration, the liquid smoke would stick to the meat and the content of liquid smoke containing organic acids would increase the value of the ash content.

3.9 Effect of Different Maceration Times of Coconut Shell Liquid Smoke on Fat Content of Duck Meat Sausage

The results of the mean value of fat content in duck meat sausages with different lengths of liquid smoke maceration were presented in Table 1. The results of the analysis of variance showed that maceration of liquid smoke with different lengths of time had no significant effect (P>0.05) on the value of the fat content of the duck meat sausage. The average value of fat content in Table 1 showed an increase in the value of fat content from P1 to P5. Maceration of liquid smoke at P5, which was 50 minutes long, had the highest average value, 14.06, with the lowest value at P1, 12.99 at 10 minutes of liquid smoke maceration. Phenol had antioxidant characteristics that could inhibit damage in products due to reducing the amount of hydrogen, therefore, it suppressed the oxidation process in fat by oxygen [24]. The increase in the value of fat content in the manufacture of coconut shell liquid smoked duck meat sausage was caused by the length of maceration, hence the phenol content would increase. Increasing levels of phenol in the product would further help inhibit damage to fat [31].

The correlation between fat content and moisture content was inversely proportional where the decreased moisture content would result in an increase in the value of the fat content, this was due to the decreased moisture content. Therefore, the phenol content in the coconut shell liquid smoke would become more concentrated with the length of maceration time. The phenol content could help inhibit the oxidation of fat and the concentrated phenol value would have an impact on the fat content because phenol in liquid smoke was a compound that functioned in the formation of fat [20]. The fat content in the duck meat sausage was in

accordance with the Indonesian National Standard (SNI 01-3820-2015) the nutritional value of the sausage was a maximum of 20%, meaning that the fat content produced by the macerated duck meat sausage with coconut shell liquid smoke still met the standard fat content in sausages.

3.10 Effect of Different Maceration Times of Coconut Shell Liquid Smoke on the Organoleptic of Duck Meat Sausage

The treatments had a significant effect on the texture value of liquid smoked duck meat sausages and panelists preferred the taste of duck meat sausages with liquid smoke maceration for 40 minutes. Texture was a physical property of structural elements derived from food. Texture formation [32] was by uniting the components in the form of an oil-in-water emulsion. Therefore, it could produce a compact texture because the texture of a good quality sausage had the characteristics of being chewy, tender, and compact. The longer the maceration time, the higher the liquid smoke attached to the meat. The addition of liquid smoke could increase the hardness value of the meat [33].

The treatments had a very significant effect on the color parameters of the panelists. Duck meat sausages with maceration time in liquid smoke for 30 minutes were preferable to duck meat sausages with liquid smoke maceration time for 50 minutes, the average color was light brown. Color was a sensory sensation, not a substance, sensory originating from radiant energy that fell on the sense of sight [34]. [11] the discoloration that occured in the meat to become slightly darker was influenced by the increasing concentration of liquid smoke given due to non-enzymatic reactions of smoke products originating from dicarbonic and carbonyl condensation reactions in smoke with free amino acids and protein amino acids. Another factor that could affect color [11] was a change in meat pigment due to myoglobin being oxidized to produce brown metmyoglobin which then mixed with H2S to form sulfur myoglobin which creates yellow or green pigments with the help of microbes. Changes in the color of the duck meat sausage could also be influenced by the pH value obtained where the lower the color it was, the paler the color of the duck meat sausage would be.

The treatment had a very significant effect on the odor value of liquid smoked duck meat sausages and the panelists preferred the taste of duck meat sausages with liquid smoke maceration for 50 minutes. [34] the formed odor came from phenol compounds that functioned as smoke flavor formers, namely 4-methyl guaicol, guaicol, and 2,6-dimethoxy phenol. The result of this study of odor on duck meat sausages was the longer maceration time was, the more concentrated odor would be produced. The siringol compound was known as a smoke flavoring compound, and along with the length of maceration, it would give the duck meat sausage a more concentrated aroma [35]. Syringol was obtained from the degradation of lignin at a temperature of 160-625°C [36], meaning that the lignin content could determine the aroma of the product.

The treatments had a very significant effect on the taste value of liquid smoked duck meat sausage and the panelists preferred the taste of duck meat sausage with liquid smoke maceration for 20 minutes, which was obtained from the average taste value of duck meat with smoked taste. [37] meat had a complex taste that came from sugar, protein, and fat with its characteristic that evaporated easily during the cooking process depending on the method, time, and temperature, hence it would produce mailard reactions between sugars and amino groups. Taste was an important factor in a food product because the sensory taste would give rise to a taste depending on the compounds that made up the used food ingredients, which not only consisted of one taste, but of various kinds of flavors that combined to form a coherent taste to produce a complete taste[38]. According to this treatment, too long maceration in liquid smoke would cause the absorption of the smoke component, namely phenol, to increase due to diffusion in the liquid smoke into the meat. The increase in the phenolic component would have an impact on increasing the smoked taste of the duck meat sausage, while the panelists' assessment did not like the concentrated taste of coconut shell liquid smoke with the lowest value in the 50-minute treatment.

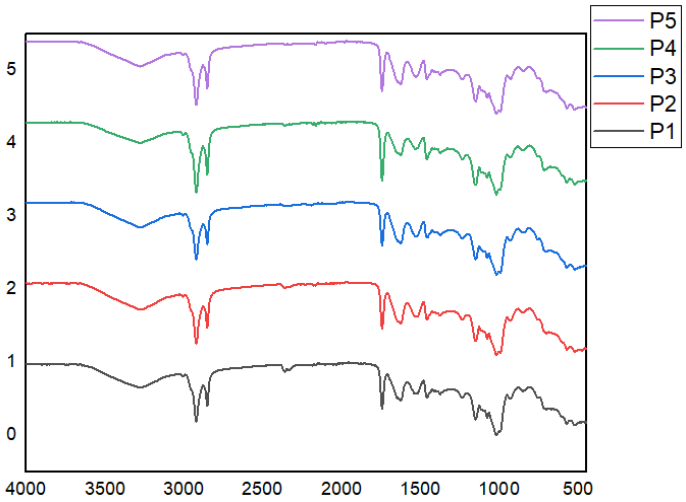

Fig. 1. FTIR spectrum of duck meat sausage with different maceration times of coconut shell liquid smoke

3.11 Effect of Different Maceration Times of Coconut Shell Liquid Smoke on Duck Meat Sausage's Fourier Transform Infrared (FTIR).

FTIR was a structural analysis based on the presence of polar bonds and functional group vibrations which were used to detect changes during processing. The image above showed the FTIR spectrum of meat with different treatments at detected wavelengths of 3500–500 cm–1. In general, the spectral patterns in this study were no different, as could be seen in Fig. 1 [39] in the wave range 1820-1660 cm-1 showed the C=O group of amide I compound (secondary structure of the protein) which gave rise to strong absorption energy and was called peak because it had the strongest and widest spectrum. This was in accordance with the results of the P1 study (10 minutes) the typical sparse absorption area at wave number 3271.73 cm-1 indicated the presence of O-H groups, the presence of absorption at wave 2852.42-2922.31 cm-1 indicates the presence of C-H groups and the absorption peaks were found in the 1744.26 cm–1 indicated the C=O ester group. At the lowest absorption value of 574.76-521.99, chloride functional groups were found. The results of the P2 study (20 minutes) the typical tenuous absorption area at wave number 3271.73 cm–1 indicated the presence of O-H groups, the presence of absorption at waves 2922.31-2852.42 cm–1 indicated the presence of C-H groups and the absorption peaks were at 1744.26 cm–1 indicated the C=O ester group. At the lowest absorption value of 571.91-523.42, chloride functional groups were found. The results of the P3 study (30 minutes) the typical tenuous absorption area at wave number 3277.43 cm–1 indicated the presence of O-H groups, the presence of absorption at waves 2922.31-2853.85 cm–1 indicated the presence of C-H groups, and the absorption peaks were at 1744.26 cm–1 indicated the C=O ester group. At the lowest absorption value of 573.34-521.99, chloride functional groups were found. The results of the P4 study (40 minutes) the typical tenuous absorption area at wave number 3276.01 cm-1 indicated the presence of O-H groups, the presence of absorption at waves 3006.45-2922.31 cm-1 indicated the presence of C-H groups and the absorption peaks were at 1744.26 cm–1 indicated the C=O ester group. At the lowest absorption value of 573.34-521.99, chloride functional groups were found. The results of the P5 study (50 minutes) the typical tenuous absorption area at wave number 3278.86 cm-1 indicated the presence of O-H groups, the presence of absorption at waves 2922.31-2853.85 cm-1 indicated the presence of C-H groups and the absorption peaks were at 1744.26 cm–1 indicated the C=O ester group. At the lowest absorption value of 573.34-524.85, chloride functional groups were found.

4. CONCLUSION

Maceration of coconut shell liquid smoke for different lengths of time had no significant effect (P>0.05) on carbohydrates, protein content, ash content, fat content, moisture content, cooking losses, pH, and tenderness but had a very

significant effect (P< 0.01) to the value of water holding capacity and organoleptic value. In this study, it could be concluded that maceration of coconut shell liquid smoke could help in reducing the value of a cooking loss, moisture content, fat content, carbohydrates, and pH and could increase the value of ash content, protein content, and water holding capacity.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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