Study of Honey Addition on Water Holding Capacity, Ph, Cooking Loss, Tenderness, and Sensory Tests in Smoked Broiler Chicken Meat

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ABSTRACT

Efforts to preserve meat to obtain shelf life can be done through curing and smoking methods. Curing is a way of processing meat by adding salt and other spices, which can improve the quality of meat in terms of aroma, taste, color and extend shelf life. One of the ingredients added in the curing process is honey. The addition of honey in smoking meat can inhibit the growth of pathogenic bacteria such as E.coli, Staphylococcus aureus. Generally, meat that has gone through the curing process is processed through the smoking stage. The aim of this research is to determine the study of the addition of honey on the water holding capacity, pH and sensory test quality of smoked broiler chicken meat. This research was carried out using experimental methods using a Completely Randomized Design (CRD) consisting of 4 treatments consisting of P0= control, P1= 10% honey, P2= 20% honey, and P3= 30% honey with 5 repetitions, so that we got 20 trial units. The data was processed using the variance test and Duncan's advanced test, while the sensory test test data was processed using the Kruskal-Wallis and Mann-Whitney advanced tests. The results showed that the addition of honey with different concentrations to smoke broiler chicken meat showed significantly different results ($p<0.05$) in all treatments on water holding capacity, pH, cooking loss, tenderness and sensory test texture tests, but had no significant effect ($p>0.05$) on sensory test tests of taste, color, aroma and total acceptability. The use of honey with a concentration of 20% showed the best results with a water holding capacity of 70.64%, pH 5.60, cooking loss 28.89%, tenderness 5.63 mm/10 seconds/50 grams, and 54.00 sensory test test texture.

Keywords: Curing, honey, smoking, Water holding capacity, pH, Cooking Loss, Tenderness, Sensory test

INTRODUCTION

Chicken meat is a livestock product in the category of white meat as animal protein because it contains quite complete nutrients which are expected to meet the protein needs of the community. According to [17], it states that national broiler chicken meat production in 2018 - 2022 was 3.06 million tons with the four largest producers being on the island of Java at 64.86% spread across the provinces of West Java (23.09%), Central Java (18.71%), East Java (14.25%), and Banten (8.82%). Meat is included in perishable food products which can reduce the physical, chemical, and sensory test quality of meat so that handling and preservation are needed which can extend the shelf life of the product.

Meat preservation efforts to obtain long shelf life can be done through the curing method (preservation) then processed by frying, grilling or smoking [6]. Smoking is generally done on meat products that are preceded by a curing process. Curing aims to obtain a stable color, good aroma and delicious texture, reduce meat shrinkage and microbial contamination during the processing process, and extend shelf life [19] Honey is one of the food ingredients that can be used as an additional ingredient in the curing method. The addition of honey in smoking meat can inhibit the growth of pathogenic bacteria such as E. coli, Staphylococcus aureus because honey can be used as a natural preservative, natural antioxidant, and as a bacteriostatic. Honey contains various

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enzymes, including catalase, oxidase, protease, peroxidase, invertase, and diastase. In addition, honey also has non-enzyme content such as carotenoids, amino acids, proteins, organic acids, Maillard reaction products, and more than 150 polyphenol compounds, including flavonoids, flavonols, phenolic acids, catechins, and cinnamic acid derivatives. Honey can facilitate metabolism and is easily digested by the body because honey is not composed of sucrose, but in the form of two types of simple sugars, glucose and fructose [12]. Honey has the potential to reduce the oxidation process in meat and inhibit the occurrence of warm-over flavor in cooked meat stored in the refrigerator [9].

Smoking is one of the food processing methods that has long been carried out through a combination of the use of heat and chemical substances from burning wood or other fuels that can provide a distinctive taste of smoked products [19] , [24]. The main chemical compounds found in smoke include formic acid, acetate, butyrate, caprylate, vanillate, syringic acid, dimethoxyphenol, methyl glycosal furfural, methanol, ethanol, octanol, acetaldehyde, diacetyl, acetone, and 3,4-benzinpyrene [8]. Chemical compounds in smoking can act as bacteriostatics, bacteriocidals that can inhibit fat oxidation. In addition, smoke contains chemical compounds phenol and formaldehyde which can form a shiny layer on the surface of the meat [7]. The heat transferred to the meat during the smoking process can cause changes in the chemical and physical properties of meat proteins, namely denaturation, coagulation and degradation, fat melting, enzyme and microbe damage, loss of some nutrients, sugar and amine reactions, and flavor component interactions. This has an effect on the tenderness and acceptability of the meat. Heat transfer into the meat is influenced by the high temperature and smoking time. Smoking temperatures that are too high for too long will cause excessive drying, while if the temperature is too low it will produce a product with an unpleasant smoke odor because the amount of phenol absorbed by the material is too high. Smoking chicken meat depends on the size of the chicken and the characteristics of the expected end product. Generally carried out at a temperature of 71^{o}C for 4 to 8 hours. The type of wood as a source of smoke should come from hardwood so that it can produce smoke with the expected quality and volume of smoke. One of the hardwood groups that can produce smoke with limited air and produce a fairly high combustion quality is coconut shell. The use of coconut shells as a source of smoke has the advantage of being easy to obtain and optimizing coconut fruit by-products [21].

The purpose of this study was to determine the effect of adding honey with different concentrations on the water holding capacity, pH, and sensory test properties of smoked broiler chicken meat.

MATERIALS AND METHODS

The ingredients used in making smoked broiler chicken meat consist of 250 grams. Chicken breast fillets (half of the breast) as many as 20 with uniform length, width and thickness, 1 kg of SNI forestry honey, 10 kg of coconut shells, and curing spices consisting of 2% table salt, 1.5% garlic powder, 1% pepper, and 0.5% nutmeg.

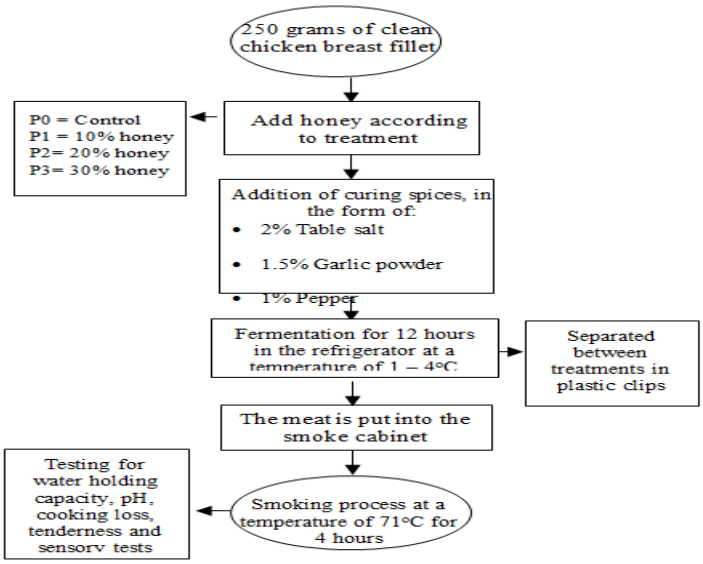

Figure 1.Preparation of meat curing and smoking

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Preparation of meat curing and smoking

The meat curing preparation procedure uses chicken breast fillets that have been cleaned of attached fat as many as 20 pieces with each weighing 250 grams for each treatment. The meat is separated per experimental sample according to the treatment and repetition and added with curing spice and honey formulation and put into plastic clips, and curing is carried out for 12 hours in a refrigerator with a temperature of 1 - 4ºC.The addition of honey was carried out in each treatment with different concentrations (P0 = 0%, P1 = 10%, P2 = 20%, P3 = 30%).

The meat that has been cured for 12 hours, the meat is put back and hung in a smoke cabinet that has been coated with aluminum foil and smoked for 4 hours at a temperature of 71 oC. The meat that has been smoked is then tested for water holding capacity, pH, and sensory tests.

Water Holding Capacity (WHC)

Water holding capacity (WHC) testing was determined using the Grau and Hamm method [18]. A sample of 0.3 g was placed on 2 glass plates covered with filter paper, pressed with a load of 35 kg for 5 minutes and the wet area was calculated. The calculation of Water Holding Capacity (WHC) can be done using the formula:

$$\text{Wet area} = \text{Wet area} - \text{Covered area}$$

$$\text{mgH}_2\text{O} = 100 - \frac{wet\ area\ (cm2)}{0.0948} - 8.0$$

$$\text{Water Content} = \frac{\text{initial sample weight - final sample weight}}{\text{initial sample weight}}\ \text{x}100\%$$

$$\text{Water Holding Capacity} = \text{Water content} - \frac{\text{mgH2O}}{300}\text{x}100$$

Cooking Loss Measurement

Measurement of cooking loss in meat is done by weighing before and after the smoking process using the [14] method. The Calculation of cooking loss in meat is done using the formula:

$$\%\ \text{Cooking Loss} = \frac{\text{initial sample weight - final sample weight}}{\text{initial sample weight}}\ \text{x}100\%$$

Tenderness Measurement

Tenderness measurement was carried out using the [1] method using a penetrometer. 30 gram chicken breast meat sample measuring 5 x 2.5 x 1.5 cm was placed on the tip of the penetrometer knife and a load of 50 kg was attached for 10 seconds, done 10 times in different places. Tenderness calculation can be calculated using the formula:

$$\text{Tenderness of meat (mm/10 sec/50 g)} = \frac{\text{Average measurement}}{\text{10 second}}$$

pH level measurement

Testing of pH levels in meat was carried out using the [3] using a pH meter. Before the measurement was carried out, the pH meter was calibrated with buffer solutions at pH 4 and 7. Measurement of pH values was carried out by weighing 2 grams of ground meat samples then diluted into 10 ml of distilled water and stirred until evenly distributed. Measurement of pH levels was carried out by dipping the electrode into the sample solution and reading the pH value on the pH meter screen.

Statistical Analysis

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This research was conducted using an experimental method, with an experimental design, namely a Randomized Design Len.gkap (RAL), consisting of 4 treatments of honey addition with concentrations of 0% (P0), 10% (P1), 20% (P2), and 30% (P3) with 5 replications, so that 20 experimental units were obtained. Measurements were carried out quantitatively and the data obtained were analyzed using ANOVA Variance Analysis and if there was a difference, it was continued with Duncan Range Test. The sensory test test was carried out on 20 trained panelists and the resulting data were analyzed using Kruskal Wallis and if there was a difference, an Mann-Whitney further test was carried out.

RESULTS AND DISCUSSION

Analysis of Water Holding Capacity, pH, Cooking Loss, and Tenderness of Smoked Broiler Chicken Meat

The results of the effect of adding honey with different concentrations to smoked broiler chicken meat on, water holding capacity and pH can be seen in Table 1.

Table 1. Water holding capacity, pH, cooking loss, tenderness in all treatments

Parameter	Treatment			
	P0	**P1**	**P2**	**P3**
WHC (%)	67.52 a	69.72 c	70.64 d	68.66 b
pH	5.95 b	5.76 ab	5.60 a	5.69 ab
Cooking loss (%)	20.56 a	35.56 b	28.89 ab	28.89 ab
Tenderness (mm/10 sec/50 g)	7.03 b	4.91 a	5.63 ab	5.22 a

P0 = control (curing spices), P1 = 10% honey + curing spices, P2 = 20% honey + curing spices, P3 = 30% honey + curing spices

Different superscripts in the same column indicate significant differences ($p<0.05$).

Water holding capacity is the ability of meat protein to bind water in meat, so that water holding capacity can be used to describe protein damage in meat. Based on table 1 shows that the use of honey in smoked broiler chicken meat on water holding capacity shows significantly different results($p <0.05$) in all treatments and is in the range of 67.52% - 70.64%.

Smoked broiler chicken meat with different honey additions showed significantly different results in all treatments, including P0 with control treatment without honey addition with the lowest water holding capacity value of 67.52%. According to [7] stated that additional materials during fermentation in the curing process can affect the water holding capacity of smoked broiler meat. The ability of each muscle to bind water because there is a similarity in protein solubility contained in each muscle.

The addition of honey to P1 – P3 showed that the water holding capacity values were 69.72%, 70.64% and 68.66% respectively. According to [1] stated that the addition of honey to smoked broiler chicken meat can affect protein and fat content.

The use of 20% honey in broiler chicken meat at P2 showed the highest water holding capacity value, which was 70.64%. This can happen because the addition of honey can affect the protein and fat content. Meat with high fat content has a higher water holding capacity value than meat with low fat content [15]. The higher the water holding capacity value, the better the ability of meat protein to retain water. The factors that can affect the protein and fat content in broiler chicken meat are the types of curing materials, especially honey as a

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sweetener to replace granulated sugar [1].

The value of water holding capacity can affect the amount of weight during cooking, the higher the cooking loss of meat, the lower the water holding capacity of the meat. Water holding capacity can be affected by age, feed, transportation, pH, humidity, treatment before cooking. cutting, and intramuscular fat [2] Water holding capacity is closely related to pH value. The further the pH isoletric point in meat (5.0 - 5.4), the water holding capacity of the meat increases [25]. The water holding capacity value can affect the color, tenderness, elasticity, juice impression and texture of the meat [22].

The pH level is an indicator of knowing the acid-base conditions that can affect the taste of the product. The pH level can be an indicator in knowing the condition of the product that has undergone decay due to the presence of microorganisms [23]. The results showed that the addition of honey to smoked broiler chicken meat had a significant effect ($p < 0.05$) on P0 without the addition of honey (control) and P2 with a concentration of 20% honey addition.

The existence of differences in pH in each treatment and significant differences in P0 and P2 can be caused by the levels of glycogen in muscle tissue, and result in the accumulation of lactic acid in meat after muscle glycogen reserves are depleted until they reach a low pH condition and can stop glycolytic enzymes in the anaerobic glycolysis process [16].

The pH value of smoked broiler chicken meat with the addition of different honey is in the range of 5.60 - 5.95. The results show that the pH of smoked broiler chicken meat is in the normal range. According to [19] stated that the pH value of chicken meat ranges from 5.30 - 6.50. The addition of 20% honey has the lowest pH level of 5.60 compared to other treatments. The content of acidic compounds can affect the decrease in meat pH. According to [20] the greater the concentration of bee honey used, the acid content in the solution increases and diffuses in the meat, so that it can cause the acidity of the meat to increase as indicated by a decrease in the pH value of the meat due to the presence of benzoic acid compounds which can cause a decrease in the pH of the meat.

The addition of honey to smoke broiler chicken meat can also affect cooking loss. Cooking loss is an indicator that can affect meat quality because it is related to the amount of water and nutrients dissolved in water due to the influence of smoking. The results showed that the percentage of cooking loss was in the range of 20.56% - 35.56% and showed that the percentage of cooking loss was higher when compared to the results of the study by [1] which was 27.12% - 29.09%.

The addition of honey with a concentration of 10% in P1 showed significantly different results ($p < 0.05$) and had a higher cooking loss value of 35.56%. This can occur because the addition of a 10% honey concentration has reached the optimum point and experienced a decrease in the percentage of cooking loss in P2 and P3 which showed 28.89% and had results that were not significantly different ($p > 0.05$). This shows that the difference in the addition of honey to smoke broiler chicken meat can affect the cooking loss value in meat. According to [19] states that low cooking loss values have better quality when compared to meat that has a higher cooking loss value, this is because the nutrients lost during the cooking process are less.

The addition of honey to smoke broiler chicken meat on tenderness showed results ranging from tender to very tender. The results showed that the percentage of tenderness ranged from 4.91 - 7.03 mm / 10 seconds / 50 grams. The results showed that the tenderness value had a higher value when compared to the research of [1] which ranged from 3.50 - 4.33 mm / 10 seconds / 50 grams and was in the range of slightly tender to tender.

The results showed that the addition of honey to smoke broiler chicken meat was significantly different ($p<0.05$). Smoked broiler chicken meat with a concentration of 10% and 20% in P1 and P3 showed significantly different results ($p<0.05$) to P0 without the addition of honey (control) in smoked broiler chicken meat. The tenderness value at P0 showed a higher result of 7.03 mm/10 seconds/50 grams compared to other treatments with the addition of different honey concentrations in each treatment. This may be due to the absence of honey treatment that can produce a more tender meat texture. Meanwhile, meat with the addition of honey showed a decreased tenderness value during the smoking process. Protein denaturation, accompanied by

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the coagulation and hardening of myofibril proteins and the pressing of water out of muscle fibers, can cause the meat to become tough and decrease tenderness. This is in line with [1] who stated that the addition of honey to smoked meat has a lower tenderness value because of the caramelization process in the honey as a result of the combination of smoke and heat in the smoking process so that the meat becomes slightly hard or tough.

Sensory test Properties Analysis of Smoked Broiler Chicken Meat

The results of the effect of using different types of flour on the texture, color, aroma, and taste of beef burgers can be seen in Table 2.

Table 2. Sensory test test of adding honey with different concentrations to smoked chicken meat

Parameter	Treatment			
	P0	P1	P2	P3
Color	40.75 a	47.38 a	40.60 a	33.28 a
Flavor	38.53 a	48.00 a	34.58 a	40.90 a
Aroma	44.33 a	38.15 a	37.42 a	42.10 a
Texture	35.20 a	38.25 a	54.00 b	34.55 a
Total Revenue	36.28 a	46.28 a	39.50 a	39.95 a

Different superscripts in the same column indicate significant differences ($p<0.05$)

Color

Color is a parameter of assessment through the sense of sight in assessing food acceptance. The results showed that smoked broiler chicken meat with the addition of different honey concentrations showed results that were not significantly different ($p>0.05$) in all treatments. The color value in each treatment was in the range of 33.28 - 47.38.

Differences in color score values in each treatment can occur because the fermentation process before smoking can produce volatile compounds typical of roasted products from the Maillard reaction due to the reaction between amino groups and reducing sugars [7]. According to [11], factors that can affect color are age, gender, race, and environment.

Flavor

The main sensory quality assessment in determining panelists' preference for a product is taste. According to [5] the chemical stimulus that arises and is felt by the tongue is taste. The results showed that the taste of smoked meat with the addition of different concentrations of honey in all treatments was not significantly different ($p>0.05$). The combination of smoke components, curing spices and the addition of honey to smoked broiler chicken meat was the main influence on the taste received by the panelists. Panelist preferred the taste most at P1, wew honey was added at a 10% concentration. This could be because the level of sweetness from the honey balanced well with the added spices whicht most panelists liked.

Aroma

Sensory quality assessment starting from a distance is aroma. Aroma can stimulate the sense of smell to the appeal of panelists which can arouse appetite to taste it [13]. The results showed that the addition of honey with different concentrations to smoke broiler chicken meat showed no significant difference ($p>0.05$) in all treatments and was in the liking range. Aroma can be influenced by phenolic compounds and smoke

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components produced. During smoking, chemical compounds contained in the smoke will stick to the meat and provide a preservative effect that can extend shelf life, extend shelf life, provide a distinctive taste and color that can affect acceptability.

Texture

Texture is an indicator that can determine the assessment and acceptance of the panelists towards the tenderness of the meat. The panelist prefer meat texure that is produced with higher tenderness. The results showed that the addition of honey with different concentrations was significantly different ($p < 0.05$) to P2 with a honey addition concentration of 20%. This can happen because the pH in P2 has a lower pH value compared to other treatments. According to [25] states that low pH in the soaking process has a positive effect on texture and increases the water capacity in it. The soaking process can tenderize and can increase the taste and water content in the meat. This can happen because smoked meat with the addition of honey above 5% has a lower tenderness level than without the addition of honey.

Total Revenue

The total acceptance of the panelists was in the range of liking. These results indicate the panelists well accepted smoked broiler chicken meat with the addition of different honey concentrations, although not significantly different ($p > 0.05$) in all treatments. Total acceptance refers to the overall level of acceptance of the panelists, including color, taste, aroma, and texture. The curing process before smoking the meat aims to obtain a stable color, aroma, texture and good deliciousness that can be well accepted by the panelists. In addition, the addition of honey plays a role in total acceptance. This is in line with the research of [10] which states that the use of bee honey solution with a concentration of 30% can improve the color, aroma, and texture properties of beef.

CONCLUSION

The addition of honey with different concentrations to smoked broiler chicken meat showed significantly different results ($p < 0.05$) in all treatments on water holding capacity, pH, cooking loss, tenderness and sensory test texture test, but did not significantly affect ($p > 0.05$) on sensory test tests of taste, color, aroma, and total acceptance. The use of honey with a concentration of 20% showed the best results with a water holding capacity of 70.64%, cooking loss of pH 5.60, cooking loss of 28.89%, tenderness of 5.63 mm/10 seconds/50 grams, and 54.00 sensory test texture test.

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