THE EFFECT OF PREHEATING USING MICROWAVE, STEAM, AND OVEN ON THE QUALITY OF PONOROGO CHICKEN SATAY

Avida Fradiana[1], Aris Sri Widati[2], Djalal Rosyidi[2]

[1] Student of Postgraduate Masters Program, Faculty of Animal Science, Universitas Brawijaya, Jl. Veteran, Malang City, 65145, East Java, Indonesia

[2] Lecturer of Animal Products Technology, Faculty of Animal Science, Universitas Brawijaya, Jl. Veteran, Malang City, 65145, East Java, Indonesia

*Corresponding Email: djalal_tht@ub.ac.id

ABSTRACT

This study aims to determine the effect of different preheating methods on the quality of Ponorogo chicken satay. The study used a Nested Completely Randomized Design. The preheating methods used include microwave, steam, and oven with a preheating time of 5 and 10 minutes. The parameters used are physical quality (pH, WHC, and cooking loss), chemical quality (moisture, protein, and fat content), and Polycyclic aromatic hydrocarbons (PAH). Data were analyzed using Analysis of Variance (ANOVA), if the results of the analysis obtained data that were significantly different or very significant, it would be continued with Duncan's Multiple Range Test (UJBD) and PAH descriptively analysis. The results of statistical analysis showed that the use of different preheating methods had a very significant effect (P<0.01) on pH and fat content had a significant effect (P<0.05) but had no significant effect (P>0.05) on Water Holding Capacity (WHC), cooking loss, moisture, and protein content. The duration of preheating in preheating method had a significant effect (P<0.05) on WHC and moisture content, but it had no significant effect (P>0.05) on pH, cooking loss, protein, and fat content. PAH content of Ponorogo chicken satay with long heating using microwave (23.35 mg/kg and 5.99 mg/kg), steam (5.48 mg/kg and not detected), oven (8.22 mg/kg and 7.31 mg/kg). This study concludes that the use of preheating method for a long time can reduce the content of Polycyclic aromatic hydrocarbons (PAH), physical, chemical, and organoleptic quality. The best model is obtained in the steam method with a temperature of 97°C.

Keywords: Ponorogo chicken satay, physical quality, chemical quality, and Polycyclic aromatic hydrocarbons (PAH).

INTRODUCTION

Satay is a processed product of chicken meat that is very well known in the community and is processed through burning. Satay is a food dish that is made by burning with charcoal coals so that the level of overripe obtained can be half cooked or perfect (Supyansyah et al., 2017). The various types of satay in Indonesia are usually named based on the place of origin of the satay recipe, the type of meat, ingredients, and the process of making it. The types of satay typical of regions in Indonesia include: Madura satay, Padang satay, Ponorogo satay, Blora satay, Banjar satay, Makassar satay, goat satay, rabbit satay and *lilit* satay. Satay of Ponorogo is known by the public because it has the characteristic that is using a spread of marinated spices before going through the burning process so that it produces a delicious and delicious taste. Beef satay is much-loved because it has a delicious, tasty, and delicious taste but there are problems in the cooking process. Satay is suspected to have chemical contaminants that are carcinogenic (Adiyastiti et al., 2014). Carcinogenic substances are substances that are in the process of burning satay that causes cancer in humans. It is suspected that carcinogenic compounds arise due to the combustion process at high temperatures. In the carcinogenic satay substances, namely *Polycyclic aromatic hydrocarbons* (PAH).

Polycyclic aromatic hydrocarbons (PAH) are a group of compounds formed as a result of incomplete combustion of inorganic substances (charcoal, oil, and gas) and organic substances, which are produced during the combustion and pyrolysis processes of carbon-containing materials such as oil, wood, waste or coal. Several factors that can affect the formation of PAH are processing temperature, processing time, the chemical composition of meat, and the treatment given. These compounds can be attenuated or will decrease if done by pretreatment using different techniques. Recently, it was found that the use of microwave treatment before roasting significantly reduced PAH concentrations. Loss of water during microwave processing in which small molecule precursors can be prevented from reaching the meat surface and is not available as a reactant for the formation of carcinogens (Barzegar et al., 2019). PAH can be reduced by preheating before burning using a microwave, oven, or steam.

In addition to using the pre-treatment method, the carcinogenic content can be suppressed through the long cooking time method. (Farhadian et al., 2010) PAH can be reduced by reducing excess fat; cooking meat at a lower temperature or for a shorter time; avoiding contact with charcoal coals when grilling; using an alternative to an electric grill with a heat source designed above the meat or vertically; applying preheating (steam and microwave) before baking, pretreatment of meat packaging (*aluminium and banana leaves*), and marinate the meat with antioxidant-rich spices. The process of burning satay using charcoal for a long time is preferred by the public because it produces a distinctive and delicious aroma. Charcoal is the result of incomplete combustion which contains PAH. In grilled meats, PAH are formed when the fat drips over the charcoal, then combine with the smoke and stick to the meat. Of course, in the use of charcoal as a combustion material, consider the length of time during cooking. The longer the process of burning satay on charcoal, will increase

*Corresponding author:
Djalal Rosyidi
Email: djalal_tht@ub.ac.id
Lecturer of Animal Products Technology, Faculty of Animal Science, Universitas Brawijaya, Jl. Veteran, Malang City, 65145, East Java, Indonesia

the PAH content in the satay, but conversely the shorter the process of burning satay on charcoal, will reduce the PAH content in the satay. Based on the description above, this study aims to reduce the content of carcinogenic ingredients in Ponorogo chicken satay by heating using a microwave, steam, and oven so that consumers can enjoy satay safely, comfortably, and healthy for consumption.

MATERIALS AND METHODS

Materials

The materials used in this study were the breast of chicken meat, wood charcoal and coconut shell, marinated spices, and peanut sauce. The tools used include bamboo skewers, basins, knives, fans, and analytical scales.

Methods

Using the experimental method with a Nested Completely Randomized Design with 2 treatment factors. Factor 1 is the form of the preheating method used, namely microwave (temperature 45°C), steam (temperature 97°C), and oven (temperature 95°C). Factor 2 is the preheating time, which is 5 and 10 minutes. The study consisted of 6 treatments with each treatment consisting of 3 replications so that there were 18 experimental units.

Ponorogo Chicken Satay Making Process

The seasonings used include marinated spices and ground peanut sauce. The marinade consists of shallots, garlic, laos, cumin, coriander, candlenut, salt, and palm sugar, while the peanut sauce consists of brown sugar, red chili, small, salt and peanuts. Lean chicken meat, thinly sliced lengthwise with a size of 5 x 2 x 1 cm, soaked in spices that have been mashed for 15 minutes. Then the meat is pierced with a skewer, every 1 skewer there are 2 pieces of meat. Water soaked with soy sauce as a dip when burning. The burning of the satay is carried out with a 7 minutes burning time treatment and the type of fuel is charcoal and coconut shell.

Research Parameters

Testing the quality of Ponorogo chicken satay includes physical tests (pH, WHC, and cooking loss), chemical tests (moisture, protein, and fat content), and PAH profile.

1. pH

   The pH test was carried out using a pH meter on meat using the procedure (AOAC, 2005). Added sample weighing 25g 50 ml of distilled water. The pH value is determined using a pH meter. The pH meter was calibrated before taking measurements using pH 4 and 7 buffers. The electrode was immersed in the solution until a stable reading was obtained at the pH meter.

2. WHC

   WHC testing was carried out using the Hamm method (1972). Prepared samples to be tested. Weighed the sample with a weight of 0.3 grams. Placed on paper Whatman no. 42. The meatball sample is clamped between two clear glass plates. Pressed with an iron plate with a weight of 35 kg for 5 minutes. Take the load and draw the shape of the sample and the wet area around the sample with a plastic sheet and marker. The wet area around the sample was measured with the help of graph paper, then entered into the Hamm formula:

$$Mg\ H_2O = wet\ area\ x\ \frac{cm^2}{0,0948} - 8,0$$

The weight of water obtained is called free water. By knowing the total moisture content, the bound moisture content can be determined. Here's the formula:

$$Bound\ water\ (Ai) = Total\ water\ (At) - Free\ water\ (Ab)$$
$$= \ldots\%\ of\ sample\ weight = WHC$$

3. Cooking Loss

Cooking loss testing was carried out using the modified Bouton et al. (1976) method. The sample was weighed with an initial weight (A), then put in polyethylene plastic, clamped the plastic, and marked according to the treatment and replication. The sample is put in a water bath and boiled at a temperature of 70-80°C and boiled for 30 minutes. The sample was removed and cooled in running water at room temperature. The sample was removed from the plastic and the surface was dried with tissue paper without pressing it, then the weight was weighed (B). Calculated results, with the formula:

$$Cooking\ Loss\ (\%) = \frac{A - B}{A}\ x\ 100\%$$

Recorded data results

4. Moisture, Protein, Fat Content

The moisture content test used the FOSS Food Scan method (AOAC, 2007). The unit power is turned on, the unit is allowed to warm up and a self-test diagnostic is performed. Selected the appropriate operator ID and product profile. The product profile is determined according to the use of the ANN Food Scan calibration for meat and meat products, version 3.00. Place the prepared sample into the sample glass. Place the sample glass in its place in the instrument. Make sure that the cup has index pins in place. Closed and locked the door. Start the analysis by pressing the start button. Enter a sample ID or sample description. Samples were removed from the instrument when the analysis was complete. Process and record the results.

5. PAH (*polycyclic aromatic hydrocarbons*)

PAH testing was carried out using the Chromatography method (Syahrir et al., 2015). Samples were taken using the Van Veen Grab tool. Wrapped the sample with aluminum foil. 10 grams of sample was extracted for 18 hours with dichloromethane and n-hexane as solvents (50:50 = v/v= 1:1) at 45°C. The resulting extract was evaporated with the solvent using a Buchi rotary evaporator to obtain Organic Material Extract (EBO) at a temperature of 45°C (EPA Method 8270). Separation of other organic substances carried out during extraction was carried out in a clean-up using alkaline alumina. The results of the distillate from the clean-up were followed by a separation process using silica gel ± alumina (1:1) to obtain two fractions, namely the aliphatic and aromatic fractions. Analyzed f/aromatic reaction containing PAH by GC-FID chromatography with an external standard method with various operating conditions of gas chromatography and obtained optimal conditions.

Data Analysis

Data were analyzed using Analysis of Variance (ANOVA) on Microsoft Excel, if the results of the analysis obtained data that were significantly different or very significant, it would be continued with Duncan's Multiple Range Test (UJBD) and PAH analysis (Polycyclic aromatic hydrocarbons) of descriptively.

RESULTS AND DISCUSSION

The Effect Of Preheating Using Microwave, Steam, and Oven On pH, WHC, and Cooking Loss Of Ponorogo Chicken Satay

The results of the analysis showed that the preheating method had a very significant effect (P<0.01) on the pH value of Ponorogo chicken satay. The effect of pH on Ponorogo chicken satay with steam preheating of 97°C occurs due to the difference in temperature

used which is higher than a microwave or oven preheating. The high pH value is caused by the high preheating temperature used so that it can damage the glycolytic enzymes in the glycolysis process. Glycolytic enzymes function in the formation of lactic acid, if the glycolytic enzymes are damaged they will not be able to produce lactic acid which affects the high pH value.

Preheating using steam with a high temperature of 97°C results in protein denaturation it damages the acidic group which causes a more alkaline/higher acid pH. The pH value is determined by the amount of lactic acid produced from the glycogen content due to anaerobic changes. After the meat is cut / post-partum there is a rate of glycolysis causing the breakdown of glycogen into glucose. Glycolysis is a process of changing glucose oxidation with the help of enzymes to produce pyruvic acid aerobically while lactic acid is anaerobic (Suhartono et al., 2021). This glycolysis process will produce lactic acid which causes a decrease in the pH of the meat. If there is a buildup of glycolysis, there will be a buildup of lactic acid, thus lowering the pH value. The higher the lactic acid, the lower the pH value.

Table 1. The average value of the effect of preheating using microwave, steam, and oven on pH, WHC and cooking loss of Ponorogo chicken satay

Variable	Treatment		
	Microwave Temperature : 45°C	Steam Temperature : 97°C	Oven Temperature : 95°C
pH	6.37 ± 0.23^a	6.71 ± 0.13^b	6.40 ± 0.12^a
WHC (%)	36.07 ± 7.84	36.10 ± 5.77	40.15 ± 4.53
Cooking Loss (%)	10.36 ± 3.26	8.95 ± 6.65	9.23 ± 4.48

Note: Different superscripts (a-b) in the same line show a very significant difference ($P<0.01$).

The results of the analysis showed that the heating method had no significant effect ($P>0.05$) on the WHC value and cooking loss of Ponorogo chicken satay. Water Holding Capacity serves to determine how much the ability of the material to bind water molecules (Poernomo et al., 2013). Preheating according to Soeparno (2005), causes changes in Water Holding Capacity (DIA/WHC) due to the solubility of meat protein. This is indicated by the amount of liquid meat that comes out (drip). The high value of WHC is caused by preheating which affects the structure of protein molecules.

The size of the WHC value occurs due to changes in the distance of the molecular arrangement of myofibril proteins, especially myosin. Preheating results in low attractiveness between adjacent molecules which can weaken hydrogen bonds, so that the protein enlarges and undergoes a loosening of the microstructure, by loosening this microstructure, the meat will absorb more water, resulting in a high WHC value. Steam preheating with a temperature of 97°C shows a higher temperature resulting in protein denaturation and shrinkage of meat collagen. The high temperature causes a decrease in the moisture content in the meat (Nguju et al., 2018). This shows that the heater has not been able to absorb the moisture content in a material so the WHC value can be said to be still high. In cooking shrinkage, preheating using a microwave can produce meat that is more quickly damaged by tissue structure, water allows no movement and is unable to maintain the moisture content in the meat so that there is a change in the shrinkage of the myofibril microstructure and shrinkage of myofilaments.

The decrease in the value of the mass loss is closely related to the protein content, moisture content, and fat content during preheating. The process of evaporation of water in the steam is carried out with water

that turns into steam due to the hot pressure of the stove below, the water vapor will hit the steamed satay, and the protein content will experience protein denaturation which causes the water in the meat to come out simultaneously, but in very small/low amounts.

The correlation between WHC and cooking loss is negative, so the higher the WHC, the lower the cooking loss. The low cooking loss value is caused by the different preheating used. (Purnomo et al., 2021) added that the factors that affect the value of cooking loss include product binders, WHC, protein content, and preheating. This makes it possible that preheating can affect protein bonds that are getting stronger so that they can bind to the liquid meat that will come out in small amounts resulting in low cooking losses. Another factor, the use of high temperatures in preheating can inhibit intramuscular fat that comes out during preheating.

The Effect Of Preheating Using Microwave, Steam, and Oven On Moisture, Protein, and Fat Content Of Ponorogo Chicken Satay

The results of the analysis showed that the preheating method had a significant effect (P<0.05) on the fat content of Ponorogo chicken satay. The highest average fat content in Ponorogo chicken satay by preheating using a microwave is 3.72 ± 0.52^{b}% while the lowest average fat content in Ponorogo chicken satay by preheating using steam is 2.68 ± 0.63^{a}%. Low or high-fat content can be affected by the processing or preheating process. High preheating using steam of 97°C is considered to be able to reduce fat content. This is because fat can be oxidized at high temperatures in the preheating process (Mardhika et al., 2020). The susceptibility of the lipid oxidation process in meat can be influenced by several factors, among others, the level of polyunsaturated fatty acids in meat, pH, disruption of muscle membrane integrity by grinding, mechanical deboning, restructuring, and cooking. Preheating using steam causes the fat to melt due to the high temperature and the dissolved fat in the water.

The high moisture content of the final product usually results in low-fat content. Fat is an important component in an emulsion system because fat is a dispersed phase. (Sumarji et al., 2019) stated that preheating can cause a decrease in fat content due to the melting of fat caused by the breakdown of fat components into volatile products such as aldehydes, ketones, alcohols, acids, and hydrocarbons, which greatly affects the formation of flavor. The difference in preheating temperature is followed by a difference in the fat content of a food ingredient. On the other hand, food products with low fat can attract consumers' interest because they do not cause side effects on health.

Table 2. The average value of the effect of preheating using microwave, steam, and oven on moisture, protein and fat content of Ponorogo chicken satay

Variable	Treatment		
	Microwave Temperature : 45°C	Steam Temperature : 97°C	Oven Temperature : 95°C
Moisture Content (%)	64.48 ± 2.04	63.60 ± 3.69	63.74 ± 2.76
Fat Content (%)	3.72 ± 0.52^{b}	2.68 ± 0.63^{a}	3.39 ± 0.71^{a}
Protein Content (%)	26.65 ± 1.49	27.31 ± 2.14	26.89 ± 1.33

Note: Different superscripts (a-b) in the same line showed significant differences (P<0.05).

The results of the analysis showed that the preheating method had no significant effect (P>0.05) on the moisture content and protein content of Ponorogo chicken satay.

Yusuf (2018) the use of preheating will affect the moisture content in the satay so that the moisture content decreases due to the shrinkage of collagen. In addition, due to

decreased protein function in retaining free water when protein denaturation occurs, namely myosin and actin, it affects structural changes and removes sarcoplasmic fluid from muscle fibers, resulting in loss of water from meat tissue. Table 2. This shows the high value of moisture content in this study due to the formation of free water as a by-product of bacterial activity, when microbes reach a constant growth phase, small molecular compounds containing water will be produced.

This study shows that the higher the temperature used, the more moisture content is lost during preheating. Rachmawan (2001) states that the higher the preheating temperature, the greater the heat energy carried by air so that the more mass of water material evaporates from the surface of the material being dried. The decrease in moisture content is influenced by cooking factors that cause liquid from inside the crab meat to seep out (drip occurs) (Tapotubun et al., 2008). The lower the moisture content, the higher the protein content. (Fitri et al., 2016) protein is a very important food substance for the body because this substance in addition to functioning as fuel in the body also functions as a building block and regulator. Protein also replaces body tissues that are damaged and need to be overhauled.

The protein content is still high because, during the preheating process, the product has not been able to release a large amount of water so that it allows the moisture content in it is still high and is followed by high protein content. (Lawrie et al., 2006) state that meat protein plays a role in the water binding of meat, high meat protein content causes an increase in the ability to hold water in meat so that it reduces the free water content and vice versa. Preheating using a microwave at a temperature of 45°C showed a protein content value of 27.31±2.14%. Microwave radiation will cause the bonds between C and H to break. The H atoms that are released from their bonds will cause changes

in the structure of the protein. Therefore, protein cannot carry out its biological activity and its solubility will decrease (Fitriani et al., 2013).

The Effect Of Preheating Using Microwave, Steam, and Oven On *Polycyclic aromatic hydrocarbons* (PAH) Analysis Of Ponorogo Chicken Satay

The results of the PAH profile *(Polycyclic aromatic hydrocarbons)* of Ponorogo chicken satay are presented in Table. 3. The results of the PAH test for Ponorogo chicken satay decreased along with the increase in the preheating temperature used. The formation of the PAH value is determined by the preheating method and the temperature used. Preheating using high temperatures is considered to reduce the PAH value rapidly. The use of the 97°C steam method produces the lowest PAH value of 5.48 mg/kg, while 45°C microwave produces 29.34 mg/kg PAH value, and 95°C oven produces 15.53 mg/kg PAH value.

Preheating can reduce the fat content in the satay so that the fat droplets that fall during burning will be less. The resulting lipid dripping on direct contact over a fire at intense heat is suitable for the formation of volatile PAH, which are then deposited on the surface of the meat as the smoke rises. Fat is the main precursor for PAH formation where the amount of fat content in processed foods affects PAH levels (Onopiuk et al., 2021). High temperatures cause the decomposition of fat content when cooked with water media, the fat will come out and dissolve with water.

This is caused by the breakdown of fat components into volatile products such as aldehydes, ketones, alcohols, acids, and hydrocarbons. Fats can be hydrolyzed to produce water-soluble glycerol and fatty acids. Fat hydrolysis is affected by temperature, moisture content, and high humidity. (Taylor et al., 1986) stated that there is a pre-heat treatment of meat products before being applied to high-temperature cooking, to shorten the cooking

time, and thereby reduce the formation of HAA. (Salmon et al., 2000) showed that by pre-treating beef patties with a microwave before frying, HAA levels could be reduced by up to 95%. If the high PAH are due to the presence of dietary fat content which contributes to PAH formation through thermal degradation or polymerization as well as through different thermal processes that affect PAH formation quantitatively. This research shows that fat content can be lowered by preheating. The heat will reduce the fat content, so it can reduce the PAH content of the Ponorogo chicken satay.

Table 3. The average value of the effect of preheating using microwave, steam, and oven on *Polycyclic aromatic hydrocarbons* (PAHs) analysis of Ponorogo chicken satay

Test Parameters (mg/kg)	Microwave Temperature : 45°C		Steam Temperature : 97°C		Oven Temperature : 95°C		Detection Limit
	5 minutes	10 minutes	5 minutes	10 minutes	5 minutes	10 minutes	
Naphtalene	-	-	-	-	-	-	5.21
Acenaphtene	7.98	5.99	5.48	-	8.22	7.31	-
Phenanthrene	-	-	-	-	-	-	5.20
Pyrene	3.76	-	-	-	-	-	2.08
Benzo(a)anthracene	2.04	-	-	-	-	-	1.43
Benzo(a)pyrene	9.57	-	-	-	-	-	8.46
Average	23.35	5.99	5.48	-	8.22	7.31	
Total	29.34		5.48		15.53		

The Effect of Nested Preheating Time In Preheating Methods On pH, WHC, and Cooking Loss of Ponorogo Chicken Satay

The results of the analysis showed that the length of nesting heating had no significant effect ($P>0.05$) on the pH value of Ponorogo chicken satay. Table 4. shows the average pH value of Ponorogo chicken satay with decreasing preheating time. The higher the temperature and the longer the preheating time, the lower the pH value. This is because the preheating process causes isomerization, decarboxylation, or molecular breakdown.

In addition, long preheating results in breaking the hydrogen bonds between water molecules, because the longer the heat will make the protein denature which results in the ability of the material to bind water will decrease resulting in a pH approaching acid. The ability of meat to bind to water is an important property because with a high Water Holding Capacity (WHC), the meat has good quality. In addition, the decrease in pH is due to the content of free fatty acids in food. pH is closely related to the resistance of foodstuffs to microbial growth, because the lower the pH of foodstuffs, the potential for spoilage microbes to develop in these foodstuffs can be suppressed. The longer the preheating, the lower the resulting pH. The lowest average pH value in the microwave with a time of 10 minutes was 6.21±0.17. This shows that the microwave can lower the pH value compared to other methods due to the use of a lower microwave temperature compared to the oven and steam.

The results of the analysis showed that the duration of nesting had a significant effect ($P<0.05$) on the WHC value of Ponorogo chicken satay. The duration of nested preheating using steam with a temperature of 97°C showed a significant effect ($P<0.05$) on the average cooking loss of Ponorogo chicken satay, accompanied by the length of nesting preheating using an oven at 95°C temperature showing a significant effect ($P<0.05$) on the average cooking loss of Ponorogo chicken satay. The use of high temperatures coupled with an increase in preheating time causes heat stress to continue to increase, thus affecting muscle, sarcoplasmic and myofibrillar fibers to shrink so that they are easy to damage.

(Lawrie., 1979) added that preheating effect on the structure of the meat which results in soft connective tissue (conversion of collagen to gelatin) and hardening of meat fibers due to coagulation of myofibril proteins. Cooking loss is affected by temperature and cooking time. The higher the cooking temperature, the greater the fluid content of the meat lost until it reaches a constant level.

Table 4. The average value of the effect of nested preheating time in preheating on pH, WHC and cooking loss of Ponorogo chicken satay

Variable	Microwave Temperature : 45°C		Steam Temperature : 97°C		Oven Temperature : 95°C	
	5 minutes	10 minutes	5 minutes	5 minutes	10 minutes	5 minutes
pH	6.53±0.18	6.21±0.17	6.75±0.14	6.67±0.14	6.42±0.15	6.38±0.11
WHC (%)	42.82±2.16^b	29.33±3.53^a	38.64±6.67^a	33.56±4.42^a	41.17±4.53^a	39.14±4.12^a
Cooking Loss (%)	7.76±2.26^a	12.96±1.05^a	3.33±0.82^a	14.57±3.89^b	5.37±1.28^a	13.08±2.01^b

Note: Different superscripts (a-b) in the same line showed significant differences (P<0.05).

The results of the analysis showed that the duration of nesting had a significant effect (P<0.05) on the cooking loss value of Ponorogo chicken satay. The duration of nested preheating using steam with a temperature of 97°C showed a significant effect (P<0.05) on the average cooking loss of Ponorogo chicken satay, accompanied by the length of nested preheating using an oven with a temperature of 95°C showed a significant effect (P<0.05) to the average cooking loss of Ponorogo chicken satay. The use of high temperatures coupled with an increase in preheating time causes heat stress to continue to increase, thus affecting muscle, sarcoplasmic and myofibrillar fibers to shrink so that they are easy to damage. Cooking loss is affected by temperature and cooking time.

The higher the cooking temperature, the greater the fluid content of the meat lost until it reaches a constant level. The higher the moisture content in the meat will reduce the fat and cooking loss of the meat, if the cooking loss decreases it will increase the WHC value, pH, moisture content, and protein content.

Processed meat products should experience a slight cooking loss because the cooking loss has a close relationship with the wetness of the meat and the longer preheating can reduce the pH, texture, and organoleptic values but the cooking loss value increases.

The Effect Of Nested Preheating Time In Preheating Methods On Moisture, Protein, and Fat Content of Ponorogo Chicken Satay

The results of the analysis showed that the duration of nesting had a significant effect (P<0.05) on the moisture content of Ponorogo chicken satay cooking. The duration of nested preheating using steam with a temperature of 97°C showed a significant effect (P<0.05) on the average moisture content of Ponorogo chicken satay. The moisture content decreases after the food has been steamed longer because steaming is a process that can reduce the moisture content in a food ingredient. The longer the steaming is done, the moisture content will decrease.

The effect of steaming can cause shrinkage in the meat which results in a lot of moisture coming out. In this study, the moisture content produced decreased with increasing preheating time. The increase in preheating time will affect the amount of liquid meat that comes out, so the moisture content produced will be lower. Heat can affect the quality of connective tissue protein in meat due to protein denaturation so that it can increase the amount of fluid that comes out of the meat by increasing the solubility of meat protein.

The use of preheating with a microwave and oven has not been able to reduce the moisture content significantly

because the temperature used is lower when compared to steam. Temperature affects the moisture content in a material. The higher the temperature and the longer the preheating, the lower the moisture content of the satay.

Table 5. The average value of the effect of nested preheating time in preheating on moisture, protein and fat content of Ponorogo chicken satay

Variable	Microwave Temperature : 45°C		Steam Temperature : 97°C		Oven Temperature : 95°C	
	5 minutes	10 minutes	5 minutes	5 minutes	10 minutes	5 minutes
Moisture Content	65.04 ± 2.65^a	63.92 ± 1.58^a	66.85 ± 0.54^b	60.36 ± 1.47^a	64.55 ± 3.57^a	62.93 ± 2.08^a
Fat Content	3.88 ± 0.48	3.55 ± 0.60	2.87 ± 0.83	2.49 ± 0.45	3.67 ± 0.64	3.12 ± 0.80
Protein Content	27.02 ± 2.19	26.29 ± 0.60	28.76 ± 1.13	25.85 ± 1.97	27.78 ± 0.29	25.99 ± 1.39

Note: Different superscripts (a-b) in the same line showed significant differences (P<0.05).

The results of the analysis showed that the duration of nested preheating had no significant effect (P>0.05) on the fat content and protein content of the Ponorogo chicken satay. The length of the preheating time will give different results on the fat content of the satay, where there is a decrease in the content in it in line with the length of the preheating time. Increasing the preheating time can reduce the fat content of foodstuffs by melting the fat, this is caused by the breakdown of the fat components into volatile products such as aldehydes, ketones, alcohols, acids, and hydrocarbons (Nguju et al., 2018). The longer preheating time results in a decrease in the fat content which melts and is lost with water where the fat will fall dripping into hot water due to evaporation (Tapotubun et al., 2008). Preheating resulted in changes in protein solubility, resulting in a decrease in the strength of myofibrillar proteins and the release of water from the microstructure of the meat. The preheating process is closely related to the temperature and duration of preheating, high temperatures and long preheating processes will cause denaturation of the nutritional content of meat such as protein and other nutrients. Although the protein is denatured at high temperatures, it does not cause much protein loss. Preheating can reduce protein content due to protein hydrolysis due to denaturation (Nguju et al., 2018). Protein will experience denaturation when heated at a temperature of 50°C to 80°C Denaturation can change the nature of the protein to be difficult to dissolve in water. Further preheating can cause denaturation, namely the destruction of the protein structure so that the protein will precipitate.

CONCLUSION

Preheating using different methods changes the pH value, fat content, and *Polycyclic Aromatic* Hydrocarbons (PAH) of Ponorogo chicken satay and the length of time nested on preheating changes the WHC, moisture content, and PAH analysis of Ponorogo chicken satay. PAH content using the preheating method decreased with increasing temperature used and preheating time. The lowest PAH content was produced in Ponorogo chicken satay which was heated using steam at a temperature of 97°C with a preheating time of 10 minutes.

REFERENCES

AOAC. (2005). Official methods of analysis of the Association of Official Analytical Chemists International Arlington. *Association of Official Analitycal Chemist, Inc.*

AOAC. (2007). Official methods of analysis of the Association of Official Analytical Chemists International Arlington. *Association of Official Analitycal Chemist, Inc.*

Adiyastiti, B. E. T., Suryanto, E., & Rusman, R. (2014). Pengaruh lama

pembakaran dan jenis bahan bakar terhadap kualitas sensoris dan kadar benzo(a)piren sate daging kambing. In *Buletin Peternakan. 38(3).* https://doi.org/10.21059/buletinpeternak.v38i3.5255

Barzegar, F., Kamankesh, M., & Mohammadi, A. (2019). Heterocyclic aromatic amines in cooked food: A review on formation, health risk-toxicology and their analytical techniques. In *Food Chemistry*. 280. https://doi.org/10.1016/j.foodchem.2018.12.058

Farhadian, A., Jinap, S., Abas, F., & Sakar, Z. I. (2010). Determination of polycyclic aromatic hydrocarbons in grilled meat. *Food Control*, *21*(5), 606–610. https://doi.org/10.1016/j.foodcont.2009.09.002

Fitri, A., Anandito, R. B. K., & Siswanti. (2016). Penggunaan daging dan tulang ikan bandeng (Chanos Chanos) pada stik ikan sebagai makanan ringan berkalsium dan berprotein tinggi. In *Jurnal Teknologi Hasil Pertanian. 9(2)*

Mardhika, H., Dwiloka, B., & Etza Setiani, B. (2020). Pengaruh berbagai metode thawing daging ayam petelur afkir beku terhadap kadar protein, protein terlarut dan kadar lemak steak ayam effects of various methods of frozen post-laying hens on the protein levels, dissolved protein and fat content of chicken S. In *Jurnal Teknologi Pangan. 4(1)*

Nguju, A. L., Kale, P. R., & Sabtu, B. (2018). Pengaruh cara memasak yang berbeda terhadap kadar protein, lemak, kolesterol dan rasa daging sapi bali. In *Jurnal Nukleus Peternakan. 5(1)*

Onopiuk, A., Kołodziejczak, K., Szpicer, A., Wojtasik-Kalinowska, I., Wierzbicka, A., & Półtorak, A. (2021). Analysis of factors that influence the PAH profile and amount in meat products subjected to thermal processing. *Trends in Food Science and Technology*, *115*(3), 366–379. https://doi.org/10.1016/j.tifs.2021.06.043

Poernomo, D., Suseno, S. H., & Subekti, B. P. (2013). Karakteristik fisika kimia bakso dari daging lumat ikan layaran (Istiophorus orientalis). In *Departemen Teknologi Hasil Perairan, Fakultas Perikanan dan Ilmu Kelautan, IPB* (Vol. 16).

Purnomo, N., Ramadhanty, D., Mansur, M., Nur, M., & Dagong, M. I. A. (2021). DNA quality of purification from beef sausage as halal authentication material based on genetic marker. *Jurnal Ilmu Dan Teknologi Peternakan*, *9*(1), 44–50.

Rachmawan, O. 2001. Pengeringan, Pendinginan, dan Pengemasan Komoditas Pertanian. Direktorat Pendidikan Menengah Kejuruan, Departemen Pendidikan Nasional. Jakarta.

Salmon, C. P., Knize, M. G., Panteleakos, F. N., Wu, R. W., Nelson, D. O., & Felton, J. S. (2000). Minimization of heterocyclic amines and thermal inactivation of Escherichia coli in fried ground beef. *Journal of the National Cancer Institute*, *92*(21), 1773–1778. https://doi.org/10.1093/jnci/92.21.1773

Suhartono, E., Komari, N., Charles, S., Tua, P., Biokimia, D., Kedokteran, F., Mangkurat, U. L., Kimia, P. S., Matematika, F., Alam, P., Mangkurat, U. L., Kedokteran, F., & Ciputra, U. (2021). *Interaksi Merkuri dan Kadmium terhadap Enzim Kunci pada Glikolisis in Siliko Interaction of Mercury and Cadmium on Key Enzymes in Glycolysis in Silico* (Vol. 2071, Issue September). https://doi.org/10.30742/jikw.v10i2.1599

Supyansyah, S., Rochmawati, R., & Selviana, S. (2017). Hubungan antara personal hygiene dan sanitasi tempat dagang dengan angka kuman pada Sate ayam di Kota Pontianak Tahun 2015. *Jumantik*, *4*(2). https://doi.org/10.29406/jjum.v4i2.861

Syahrir, M., Apriilita, N. H., & Nuryono. (2015). Validasi metode analisis

polisiklik aromatik validation of analysis method of polyciclic aromatic. *Jkti*, *17*(1), 9–14.

Tapotubun, A.M., Nanlohy, E.E.E.M., & Louhenapessy, J. M. (2008). Efek waktu pemanasan terhadap mutu presto beberapa jenis ikan. Jurnal Ichthyos 7(2): 65-70.

Taylor, S. E., Falke, R. L., Shoptaw, S. J., & Lichtman, R. R. (1986). Social support, support groups, and the cancer patient. *Journal of Consulting and Clinical Psychology, 54*(5), 608–615. https://doi.org/10.1037/0022-006X.54.5.608

Yusuf, B. (2018). Pengaruh Lama Pembakaran Dan Jenis Bahan Bakar Terhadap Keempukan, Kadar Protein, Lemak, Dan Kadar Air Satay Daging Kambing. Skripsi. Program Studi Peternakan Fakultas Peternakan Universitas Brawijaya Malang.