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The physico-chemical Properties of Beef Meatballs processed by Addition of Different Salt Concentration Using the Ohmic Heating method

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Abstract

Meatballs are generally cooked using the conventional method, namely the conduction method or using a stove, this cooking has several drawbacks including the amount of energy wasted during cooking, a long time and an uneven level of maturity. Currently, many ohmic cooking technologies have been developed as a substitute for conventional cooking. This technology has advantages such as being environmentally friendly because it does not use fossil fuels and the temperature is easily controlled. This technology uses the principle of electrical resistance (ohms) to generate heat, so that the heat that arises comes directly from the product itself, not from heat that is outside, such as fire or radiation. The main requirement that must be met is that the material must have conductivity or be able to conduct electric current. Salt is one of the electrolytes that are able to conduct electric current so that ohmic technology can be applied to meatballs. This study aims to determine the effect of salt concentration on the physico-chemical characteristics of beef meatballs. Three levels of salt concentration (2%, 3%, and 4%) tested on 9 samples of meatballs. The results showed an increase in the strength of Gel ($P<0.01$), antioxidant activity ($P<0.05$) and dissolved protein content ($P<0.01$) with increasing salt concentration given. This study concluded that the use of ohmic technology gave good characteristics of meatballs where this cooking was able to increase gel strength, antioxidant activity and protein content.

Keywords : Ohmic heating, meatball, salt, cooking time, beef

INTRODUCTION

Meatballs is one of the farm products made from grinding meat mixed with binders and spices then formed into round and cooked (Tiku *et al*., 2019). Cooking meatballs generally use the conventional way of using fire from the stove as a source of heat. The ripeness has several

shortcomings including the amount of energy wasted, relatively long time, and uneven maturity due to the penetration of heat that starts from the outside inside. The processing technology that is currently widely developed is ohmic technology (Ito *et al*., 2014). Ohmic's heating uses electrical current resistance to generate heat using Ohm's principle (Varghese *et al.*, 2014).

The requirement that must exist in a product to be cooked using ohmic cooking is that the product must be conductor or able to conduct electrical current (Richa *et al*., 2017). Sastry (2002) ohmic Heating basically applies contact between foodstuffs and some electrodes that have potential differences or voltages. To generate heat, foodstuffs must have electrical conductivity (Alwis and Frayer, 1992).

The use of the Ohmic cooking method is used to speed up cooking time which can cause damage to protein and other meat nutrients (Yu *et al*., 2017). Another advantage of using the Ohmic method is that time will be more effective with even heat so that the possibility of partial damage can be avoided (Anderson, 2003).

This Ohmic technique application can work optimally because of the salt in the meatball product. Therefore, it is very important to know what the optimal salt concentration is so that the meatballs become perfectly cooked. The parameters used in this study to measure the characteristics of meatballs cooked using ohmic technology were the pH value, antioxidant activity, and gel strength of the meatballs.

MATERIALS AND METHODS

Sample Preparation

The meatballs are made from three doughs with the composition of the second class beef 500 gr each, then other additional ingredients are added (tapioca flour, pepper, flavoring, shallots, garlic and egg white) into each dough. Then each dough is added with salt with different concentrations of 2%, 3% and 4% of the weight of the dough. Each treatment was repeated 3 times. After that, all the ingredients are mixed and ground until smooth. Then the dough is formed into a round shape. The meatballs are then cooked using ohmic technology at a voltage of 140V. After the meatballs are cooked, the pH value, antioxidants, and gel strength of the meatballs are tested.

Parameters Measurement

Parameters measured are pH value, antioxidant activity, and gel strength. The pH is measured using pH meter (Hanna-pHmeter) by means of 2 gr meatballs dissolved on a 2 ml aquades then pH meter plugged in the solution to get its value. Antioxidant activity is measured using the DPPH method (Tristantini *et al.*, 2016). Absorbent measurements are performed at a wavelength of 515 nm using a spectrophotometer (Rahman, 2016). Gel strength measurement is measured using Texture Analyzer tool by using a 5 mm round probe with a translucent speed of 1mm/s (Atma *et al*., 2018).

Dissolved protein content was measured using the Lowry method, the measurement procedure was to insert a sample of 1.5 g into a graduated tube, then add 7.5 ml of distilled water. The mixture was homogenized using a vortex. The mixture was centrifuged for 15 minutes, and then the precipitate and supernatant were separated. The supernatant was boiled on a hotplate. Samples were centrifuged for 15 minutes. The sample was separated from the

supernatant for the last test, 2 ml of the supernatant was taken and 1 ml of 10% TCA solution was added, then the solution and precipitate were separated by centrifuging for 15 minutes. 0.1 ml of TCA sample extract was added with 1.9 ml of distilled water and 2.5 ml of Lowry's reagent was added. The mixture was homogenized and stored at room temperature for 10 minutes. Then 0.5 ml of Folin reagent was added and incubated at room temperature for 30 minutes until a blue colour was formed. Furthermore, the absorbance of the sample was measured on a spectrophotometer with a wavelength of 600 nm, using a standard solution of Bovine Serum Albumine (BSA), the dissolved protein value was read on the monitor screen. Dissolved Protein content is calculated by the following formula:

$$\text{Dissolved protein content (\%)} = \frac{\text{A Samlel} - \text{A Contol}}{\text{A Sampel}} \times 100$$

Keterangan:
A_{Sampel}: Absorbansi Sample
$A_{Kontrol}$: Absorbansi Control

Antioxidant activity was measured using the DPPH method. Absorbance measurements were carried out at a wavelength of 515 nm using a spectrophotometer. The sample was weighed as much as 10 g and then dissolved in a 10 ml volumetric flask using methanol, so that a sample with a concentration of 10 mg/ml was obtained. Sample was diluted with methanol to obtain the solution with concentrations of 10, 30, 50, 70 and 90 g/ml. Each 0.2 ml of the solution was added with 3.8 ml of 5.8 PHg DPPH solutions and 0.2 ml of methanol solution. The solution was left for 30 minutes and kept away from light. Absorbance measurements were carried out at a wavelength of 515 nm using a spectrophotometer. The amount of antioxidant activity is calculated by the formula:

$$\text{DPPH Radical Scavenging Efect (\%)} = \frac{\text{A DPPH} - \text{A Sample}}{\text{A DPPH}} \times 100\%$$

A DPPH : Absorbansi DPPH
A Sampel : Absorbansi Sample

Gel strength was measured using a Texture Analyzer using a 5mm round probe with a penetration speed of 1mm/s.

Data Analysis

All data was recorded and collected in a database and successively analyzed by SPSS (Statistical Package for Social Science (Arkkelin, 2014) Ver. 16) software.

RESULTS AND DISCUSSION

Table 1 provide data of average pH, antioxidant activity and gel strength of profile of meatballs with different salt concentration. An explanation of the data can be explained in each section.

Table 1. Flatten the pH of meatballs on ohmic heating with different concentrations of salt.

Salt Content (%)	pH	Antioxidant (%)	Gel Strength (kg.cm)	Dissolved Protein (mg/ml)
2	5.16±0.14[a]	58.17±1.85[a]	2.29±0.15[a]	1,41±0,04[a]
3	5.23±0.06[a]	57.35±2.57[a]	2.48±0.07[b]	1,46±0,09[a]
4	5.28±0.10[b]	60.93±2.20[b]	2.48±0.04[b]	1,59±0,10[b]

Description: Different superscript in the same column or row show very significant differences (P<0.01)

pH

The difference in the pH value of the meatballs is thought to occur due to the hydrolysis of salt during heating. Chang (2006) stated that when a reaction occurs between anions or cations of salt or both with water, the hydrolysis of salt usually affects the pH of the solution. Sodium chloride (NaCl) has a pH value of 7 (normal), but after it is added to the product, the final pH of the meatball will increase along with the given salt concentration. The average pH value of each sample of meatballs with the addition of salt 2, 3, and 4% was 5.16, 5.23, and 5.28. This pH value is lower than the pH of the added salt. This gives an indication that there is an effect of adding other ingredients and treatments that make the pH lower. It is suspected that the pH of the product is influenced by the pH of the meat because meat has the largest percentage in this meatball dough. Yanti *et al*., (2008) showed that under normal conditions the pH value of beef ranges from 5.46-6.29, where in such conditions it can be said that the meat has an acidic pH.

Dissolved Protein

The increase in salt concentration is directly proportional to the increase in soluble protein in meatballs. The salt concentrations of 2% and 3% did not show a significant difference (P>0.05) to the soluble protein of meatballs. Salt concentrations of 3% and 4% showed a significant increase in dissolved protein (P>0.05). However, at concentrations of 2% and 4% showed a very significant increase in dissolved protein (P<0.01). The increase in dissolved protein in meatballs after cooking is thought to occur due to the interaction between salt ions and protein positive groups during cooking. Khairuzzaman, (2016) the addition of salt both at the beginning and end of the aging process can increase the solubility of salt-soluble protein in meat. The addition of salt can increase protein solubility because salt weakens the interaction between protein groups with different charges.

Antioxidant Activity

The increasing concentration of salt added to the meatball dough makes the antioxidants increase. This significant increase (P<0.05) was seen between concentrations of 2% and 3%, although at a concentration of 3% it was significantly lower (P<0.05). The increase was very striking between 2% and 4%. This activity indicates that the compounds contained in meatballs

play an active role in fighting free radicals (Hajrawati *et al.,* 2021). One source of antioxidants in meatballs is the result of protein dissolved into amino acids and polypeptides. The dissolved occurs due to heating so that the protein is denatured into amino acids and polypeptides. This can be seen in Table 1, which is the result of measuring the dissolved protein content in meatballs. Meatball cooking method was using ohmic technology. Nahariah *et al.*, (2015) stated that protein damage affects the formation of antioxidants during the drying period. Materials that contain lots of antioxidants are added to food products aimed at capturing more free radicals.

Gel Strength

The strength of the meatball gel increased with the increase in the concentration of salt added to the meatball dough. The salt concentration is directly proportional to the strength of the meatball gel, the higher the salt content in the meatball, the higher the gel strength value. Based on the measurement of the strength of the meatball gel, the addition of 2% salt showed a very significant difference ($P<0.01$) with the addition of 3 and 4% salt. Meanwhile, meatballs with 3% salt concentration did not show a significant difference ($P>0.05$) with meatballs with 4% salt concentration. Meat myosin protein gel forms a gel due to swelling of starch granules from tapioca flour which is added to meatball dough as a binder and filler, where starch interacts with protein and causes water absorption during heating. Salt plays a major role in binding water where salt has properties that are able to bind water well. Starch plays an important role in determining the texture of food, where a mixture of starch granules and water when heated will form a gel (Cornejo-Ramirez, 2018). Starch that turns into a gel is irreversible where the attached starch binds to each other to form lumps so that the viscosity increases (Godswill, *et al*., 2019).

Starch acts as a weak acid ion exchange, and cation tends to protect and stabilize granules structures, while anion acts as a gelatinization agent that can break hydrogen chains (Oosten, 1990).When salt (Sodium chloride) is added to the starch dissolved in water, some of the alcohol groups in the starch granule turn into a group of sodium alkoholate. This cluster can dissociate better, resulting in potential dough that makes starch granules look like they have a double layer of cation. These cation layers lower the diffusion of chloride ions, which are the anions that trigger gelatinization. Therefore, to make hydrogen bonds break and cause gelatinization, it takes a higher temperature and a longer time (Akintayo *et al.,* 1999).

CONCLUSION

This study concludes that the use of ohmic technology to cook beef meatballs can produce good meatball characteristics where the addition of salt makes gel strength, antioxidant activity and dissolved protein content increase with the addition of salt concentration. The best product characteristics are meatballs with the addition of 3% salt concentration.

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