Physical and organoleptic properties of chicken meatball prepared with varied gelling agents

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Abstract. Meatballs are popular in meat processed foods. Sometimes the addition of gelling agent is needed to produce preferred meatballs. The purpose of this research was to determine the physical and organoleptic properties of chicken meatball using different gelling agents (gelatin, carrageenan, and commercial agar-agar). The meatball was prepared from boneless and skinless chicken breast and thigh. Meatballs were produced with 3 percent addition of different gelling agents. The variables measured were physical properties (yield, water holding capacity, and tenderness) and organoleptic properties (color, smell, texture, taste, and elasticity). The research was done by completely randomized design, then the data collected were analyzed using analysis of variance followed by Duncan's New Multiple Range Test. The results indicated that the gelling agents had a significant effect (P<0.05) on meatball yield, but no significant effect on water holding capacity and tenderness. Gelling agents also showed a significant effect (P<0.05) on taste and texture, but no significant effect on color, smell, and elasticity. In conclusion, chicken meatball with different gelling agents had different physical and organoleptic properties.

1. Introduction

Meatball is a favorite dish among Kendari people, judging by the abundant meatballs sellers around town. Meatball is produced from meat, either beef chicken, and even fish meat by commusion method, a method to reduce particle size by grinding. The grinded meat then mixed with other ingredients and flour then made into balls shape before boiling. Chicken meatball is the most favorite among other meatballs because of the rich flavor and it's relatively cheaper than beef meatballs.

Chicken meatballs has more tender characteristic than beef meatball. Montolalu et al, 2013 [1] stated that broiler meat is widely used as meatball because of its tenderness and softness. Besides the taste, tenderness is one of the indicators for consumers' evaluation. Consumers tend to choose more tender and easier to chew meatballs. Sunarlim, 1997 [2] stated that meatballs of consumers' choice had tenderness scale between 10.02 to 10.04 mg·s⁻¹.

Meatball's quality depends greatly on the quality of its ingredients including meat, flour, spices, and also permissible food additive. One of the food additive that is allowed to be used is a tenderizer called sodium tripolyphosphate (STPP). STPP is one kind of salts which is widely used to make the meatballs more tender. The amount of STPP allowed in food is 0.3% from total ingredient weight [3], whereas Hatta and Murpiningrum, 2012 [4] stated that 0.5% STPP in ingredients could increase meatballs tenderness.
As chemical food additive, STPP usage needs to follow the permissible dose, but most meatballs producers didn't abide by the rules and it may danger the consumers because consuming food containing STPP in long term can give negative impact to consumers health. Rahayu, et al., 2016 [5] stated that consuming a massive dose of synthetic food additive may lead to heart and lungs problem, high blood pressure, diabetes, stomach illness, obesity, and cancer.

To reduce the usage of synthetic food additives, especially in the meatballs industry, natural food additive can be an alternative for meatball tenderizer. Carrageenan, gelatin, and agar-agar are some examples of natural food additive that are commonly used as a tenderizer in food industries. Abubakar et al., 2011 [6] has experimented with up to 2% carrageenan as tenderizer of duck meatballs. Gelatin is commonly used as a food additive in candies making, but Fahrurriza, 2013 [7] has experimented using gelatin as tenderizer in lamb meatballs. Meanwhile, agar-agar is made from processed seaweed and has the same characteristic as carrageenan. STPP, carrageenan, gelatin, and agar-agar have the same function to hold water to make more tender product.

An experiment on comparing natural food additives for chicken meatballs tenderizer shall be conducted to replace synthetic food additives so healthier meatballs can be produced.

2. Material and Methods
The samples used in this research are chicken meatballs with different food additives: carrageenan, gelatin, agar-agar (Swallow Globe), and STPP. Other ingredients used are tapioca flour and spices such as garlic, pepper, and salt.

Chicken meatballs were made based on the method used by Sunarlim, 2000 [8]. Boneless and skinless chicken meat was cut into small pieces, and then put into food processor while adding half portion of ice, gelling agents, and salt then grinded for two minutes. The filling flour and other spices and other half portion of ice then added to mixture before further grinding for one minute. The mixture then kept in 10°C refrigerator for 10 minutes. Water was brought to boil then lower the temperature to 70-80°C. The mixture then shaped into balls and put in 70°C water for 10 minutes, then put into 90°C water until the meatballs float for 15 minutes.

The variables monitored in this research are physical characteristics (yield, water binding ability, and tenderness), chemical characteristics (dry matter, protein content, fat content, and ash), and organoleptic characteristics (texture, tenderness, flavor, and aroma). Meatball yield were measured by the following equation:

\[
\text{Meatball yield} = \frac{\text{meatball weight}}{\text{Meat weight}} \times 100\%
\]

Water binding ability was measured by the centrifuge method. One gram of sample was put into the centrifuge tube then 10 ml of water was added to the tube. The mixture then mixed by using vortex until it was homogenous then incubated at room temperature for 30 minutes. The samples were then centrifuged for 30 minutes by 3500 rpm. Supernatant volume then measured with 10 ml measuring glass. Absorbed water was calculated using the difference of initial water volume with supernatant volume converted in gram with the assumption that 1 ml water was equal with 1 gram of water. Water binding capacity is calculated as such:

\[
\text{Water binding capacity (g/g)} = \frac{\text{supernatant volume (g) X water density}}{\text{Sample weight (g)}}
\]

The water leaking from the sample was assumed as the ability of meat to absorb water.

Shear force value was evaluated using the method mentioned in Abustam, 2013 [9]. Samples were cut into cylinders using prepared tools (CD-Shear force), then put in the designated place. The handle then pulled down until the samples are cut through. The weight could be seen on the scale in kilogram (kg). shear force value is calculated by dividing weight (kg) by sample surface (cm²).

Organoleptic parameters consisted of texture, tenderness, flavor, and aroma. These parameters also known as hedonic scales, as mentioned in table 1.
Table 1. Hedonic Scale for Evaluating Chicken Meatballs

| Sensory evaluation | Hedonic scale | Criteria                  |
|--------------------|---------------|---------------------------|
| Aroma              | 1             | Strongly disliked         |
|                    | 2             | Disliked                  |
|                    | 3             | Quite liked               |
|                    | 4             | Liked                     |
|                    | 5             | Strongly liked             |
| Texture            | 1             | Strongly disliked         |
|                    | 2             | Disliked                  |
|                    | 3             | Quite liked               |
|                    | 4             | Liked                     |
|                    | 5             | Strongly liked             |
| Flavor             | 1             | Strongly disliked         |
|                    | 2             | Disliked                  |
|                    | 3             | Quite liked               |
|                    | 4             | Liked                     |
|                    | 5             | Strongly liked             |
| Tenderness         | 1             | Strongly disliked         |
|                    | 2             | Disliked                  |
|                    | 3             | Quite liked               |
|                    | 4             | Liked                     |
|                    | 5             | Strongly liked             |

Note: Modified scale [11]

This experiment was performed by using a completely randomized design which consisted of 5 treatments with 3 repetitions. The data collected then analyzed by Analysis of Variance with 5% error deviation. To discover the treatments' effects, we performed Duncan Multiple Range Test [11].

3. Discussion

Table 2. Physical qualities of chicken meatballs with different gelling agents

| Parameter                | Gelling agents |
|--------------------------|-----------------|
|                          | Control | Gelatine | Carrageenan | Agar-agar | STPP |
| Yield                   | 97.02m   | 109.06b  | 91.39a      | 102.39m   | 96.93m |
| Water binding capacity  | 26.67    | 28.33    | 28.33       | 29.33     | 30.00 |
| Elasticity              | 0.13a    | 0.11a    | 0.15a       | 0.17a     | 0.23a |

Different superscript showed significant difference among treatments

3.1 Meatball yield

The result of the experiment showed that there are variations on the amount of chicken meatball yield (table 2) using 3% of different gelling agents (gelatine, carrageenan, and agar-agar). Chicken meatballs prepared with gelatine as gelling agent showed higher yield than other gelling agents. Gelatine could increase water binding capacity by electrostatic interaction with casein (COO---Ca2+-COO-) so that hydrophobic interaction was limited on non-polar molecules so it might increase the product yield. Carrageenan and agar-agar are seaweed products that could produce gel. Seaweed products have been known as gelling agents or emulsifiers for the food industry and carrageenan has been known for gelling agents in meat products. The result of this study showed that using 3% carrageenan or agar-agar as gelling agent did not affect chicken meatball yield.

3.2 Water binding capacity

The water-binding capacity of meatball dough is the ability to maintain the amount of water bind throughout the cooking process. The averages of water binding capacity value of chicken meatballs with varied gelling agents are presented in table 2. The variation of gelling agents on chicken meatballs did not affect the water-binding capacity (p>0.05), but we observed the tendency of increasing the water-binding capacity of chicken meatballs prepared with gelling agents than control.
Gelatine, carrageenan, and agar-agar had the same ability to emulsify and producing gel. These ingredients are hydrocoloidal water-absorbing, so adding these ingredients could increase water binding ability of the dough while cooking. Adding sodium tripolyphosphate in sheep meatball resulted in better water binding capacity than adding gelatine and albumen [7].

The result of this experiment showed no significant effect of adding different gelling agents to water binding capacity of chicken meatballs. The water-binding capacity of meat is not only affected by gelling agents, but also by extracted protein, absorbed water, dough viscosity, acidity, heating, salt concentration and variety [6].

3.3 Elasticity
Elasticity of chicken meatballs prepared by adding varied gelling agents (gelatine, carrageenan, agar-agar) and that without gelling agent showed no difference, but those prepared by adding STPP showed significantly bigger elasticity value. The bigger the elasticity value indicated that the meatballs are more elastic and less tender. Sodium tripolyphosphate (STPP) was a food additive to make meatballs more elastic [12]. STPP increased ionic force that had an impact on water binding ability [16]. As the water binding capacity increased, the elasticity of meatballs also increased. STPP also could reduce cooking loss and act as an antioxidant [12].

3.4 Organoleptic characteristic
Organoleptic testing is important to measure consumer’s palatability of meatballs produced. The organoleptic characteristics tested in this study were color, aroma, texture, flavor, and tenderness (table 3).

| Parameter | Control | Gelatine | Carrageenan | Agar-agar | STPP |
|-----------|---------|----------|-------------|-----------|------|
| Color     | 3.35    | 3.30     | 3.30        | 3.50      | 3.20 |
| Aroma     | 3.15    | 3.40     | 3.40        | 3.45      | 3.40 |
| Texture   | 3.25    | 3.25     | 3.25        | 3.5       |      |
| Flavor    | 2.65a   | 3.50b    | 3.50b       | 3.50b     | 3.20b|
| Tenderness| 3.10    | 3.10     | 3.10        | 3.25      | 3.35 |

Different superscript showed significant difference among treatments

Adding varied gelling agents did not affect color, aroma, texture, and tenderness of chicken meatballs, but it showed to affect flavor. The average meatballs color, aroma, texture and tenderness score indicated that those characteristics of meatballs were quite liked. The color of meatballs were mainly affected by main ingredients used and non-enzymatic browning reaction between protein and sugar. Texture and tenderness of meatballs products were determined by its water content [12], and it can be increased by adding gelling agents. Higher water content will increase the tenderness, but adding 3% of varied gelling agents did not show the desired effect.

The flavor showed a significant difference between treatments and control, but no difference between treatments which indicated that adding gelling agents could increase flavor likeness. Flavour was mostly determined by the ingredients used in making meatballs, and adding Euchema cottonii seaweed as a gelling agent could increase flavor likeness [13].

4. Conclusion
Varied gelling agents in chicken meatballs production increased flavor likeness and yield (gelatine). Gelatine can be used as a substitute for the chemical gelling agent (sodium tripolyphosphate) that is still widely used in the food industry.

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