The Effect of Gelatin on Water Holding Capacity, Water Activity, Water Content, and Randement of Chicken-Liver Meatball

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Abstract. Gelatin ($C_{102}H_{151}N_{31}$) was used as the addition on chicken liver meatballs and had functioned as a binder agent to improve the texture of the liver which crumbles easily by binding the water during heating. The objective of this research was determining the effect of gelatin as the addition in different levels on WHC, Aw, water content, and randement of chicken liver meatball. The materials used for this research were chicken liver meatballs added with different levels of gelatin consisting of 0%, 3%, 6%, and 9%. The method of this research used experimental research, counted with Completely Randomized Design (CRD) used 4 treatments and 4 replications. Variables of this research were WHC, Aw, water content, and randement. The result showed that average of WHC on each level are 46.39% ; 47.97% ; 48.73% ; 49.24%, Aw: 0.88; 0.88; 0.88; 0.90, water content: 69.00%; 68.38%; 66.50%; 64.37%, randement: 94.04%; 96.12%; 97.10%; 100.20%. Addition of gelatin did not give significant effect on WHC, Aw, water content, and randement. In conclusion, the addition of gelatin in different levels on chicken liver meatball did not give significant effect on WHC, Aw, water content, and randement

1 Introduction

The meat content in 1 broiler is 37 grams of protein, 295 Kcal of energy, and 14.7 grams of fat. Meatballs are processed meat products produced from a mixture of ground meat, flour and spices which are formed into balls of various sizes and shapes. The meatball processing consists of three stages, the first stage is making meatball dough, the second stage is molding meatballs, and the last stage is cooking meatballs [1]. The provisions for meatball production according to SNI 3818:2014 are a minimum protein content of 11%, a maximum fat content of 10%, a maximum water content of 70%, and a maximum ash content of 3%. Raw materials for making meatballs can come from other livestock such as chickens, cows, pigs, rabbits and other livestock.

Poultry meat is one of the most popular and frequently consumed meats among the public. Chicken meat has a protein content around 18.20 grams, fat 25 grams, and has calories 404 Kcal per 100 grams [2]. Meat muscle protein consists of 70% myofibril protein and about

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30% water-soluble protein. Myofibril protein contains around 32%-38% myosin, 13%-17% actin, 7% tropomyosin and 6% stromal protein. Myosin is a protein component that is responsible for the gelation process, while actin and other proteins regulate the viscoelastic properties of the gel formed [3]. The demand for purebred chicken meat by the public increases every year, causing the production of purebred chickens also increasing, currently the production of purebred chicken meat in East Java has increased by 35% from 2021 [4].

The high production of chicken meat causes production of by-products like a chicken's liver soaring. Processed chicken liver products can be improved by developing innovative chicken livers into meatball products. Chicken liver contains globular proteins such as globulins which have an unstable structure [5]. Apart from that, the high fatty acid content also makes chicken liver have low emulsion stability. Therefore, an additional ingredient is needed to stabilize the emulsion in the chicken liver meatball mixture to produce high quality meatballs.

The ingredients to make the dough can affect the quality of the meatballs. Meatballs production requires a binder to stabilize the emulsion, reduce cooking losses, and increase water holding capacity [6]. Gelatin is one of the ingredients that can be used as a binder. Gelatin is the product of a hydrolysis reaction of collagen originating from animal connective tissue such as skin, animal bones, etc, which produces a heterogeneous mixture of polypeptides [7]. Gelatin contains polar amino acid groups that have hydrophilic properties so that they can bind water in large amounts [8]. The use of gelatin as binder in chicken liver meatballs have not been widely researched and studied, therefore it is necessary to conduct research on the effect of additional gelatin with different levels on WHC, Aw, water content, and randement of chicken liver meatballs**.**

2 Material and Method

The research was begun from January 2023 to March 2023 at Animal Products Technology Laboratory, Faculty of Animal Science, Universitas Brawijaya, Malang. The ingredients included chicken liver, beef bone gelatin Hakiki, garlic, shallots, pepper Ladaku, salt Dolpin, sugar Gulaku, tapioca flour Pak Tani Gunung, ice cubes and chicken egg white.

The research method was an experiment and counted with Completely Randomized Design (CRD) consisted of 4 treatments T0, T1, T2 and PT (gelatin 0, 3, 6 and 9%) and 4 replications. Variables consisted of WHC, Aw, water content, and randement. Meatball production method [9], WHC used Whatman 42 filter paper, 35 kg load, and glass plate [10]; Aw used Aw meter Rotronic HP23 [11]; water content testing used an oven Chemitech, crucible, analytical scales AB204-S, exicator Duran, and glass clamp [12]; randement used analytical scales AB204-S [13].

3 Results and Discussion

The results of the research on chicken liver meatballs are as shown in Table 1.

Table 1. The results of chicken liver meatballs with additional gelatin

Treatment	WHC (%) ± SD	Aw ± SD	Water Content (%) ± SD	Randement (%) ± SD
T0	46.39 ± 8.86	0.88 ± 0.02	69.00 ± 1.87	94.04 ± 0.90
T1	47.97 ± 2.98	0.88 ± 0.03	68.38 ± 3.09	96.12 ± 2.98
T2	48.73 ± 3.46	0.88 ± 0.03	66.50 ± 2.65	97.10 ± 4.38
T3	49.24 ± 2.55	0.90 ± 0.02	64.38 ± 2.10	100.20 ± 1.86

Explanation: The addion of gelatin with different percentages in chicken liver meatballs showed no significant difference in each treatment on particle size (P>0.05).

3.1 Water Holding Capacity (WHC)

WHC, referred to as water absorption ability, is the capacity of meat to bind water in the protein matrix or water that is mixed in when there are external factors such as chopping, heating, pressure and grinding. The result showed that additional gelatin with different levels had no effect (P>0.05) on the WHC of chicken liver meatballs. Research [14] explains that the ability of water absorption is influenced by the size of the water content in the resulting product. The water absorption ability of a product is generally opposite of its water content value. The higher WHC value of meatballs, the lower value of water content, and vice versa. Polar amino acid groups in proteins in the form of amino, hydroxyl, carboxyl, and sulfhydryl have a hydrophilic nature that allows them to bind water in quite large quantities [8].

The largest WHC value was found in the T3 treatment 49.24% ± 2.55 while the smallest WHC value was found in the T0 treatment 46.39% ± 8.86. The addition of gelatin to meatballs can increase WHC. The results of this study are in line with research [15] that the addition of collagen can increase the water absorption ability of the product due to the binding of gelatin protein to water molecules. Enhancement in WHC value in beef meatballs is in line with the ability of beef meatballs to bind large amounts of water so that it can increase the chewiness value of beef meatballs which is assisted by starch capability to bind water. The gel formed in the meatballs due to the gelatinization process will help the absorption of water and hold it in the gel matrix which causes the WHC value to increase and cooking loss to decrease during the heating process [16].

3.2 Water Activity (Aw)

Water activity is the amount of free water which is related to the water content in the product that affects the shelf life used by microbes to live. The results showed that chicken liver meatballs with additional gelatin at different levels had no effect (P>0.05) on the Aw value of chicken liver meatballs. Aw value and water content value of a product are closely related. The high and low Aw value will be in line with the water content value. The amount of free water in meatballs increases due to enhancement of water content in the meatballs and vice versa. The rise of water content indicates that there is some water evaporating during the heating process, water that evaporates is free water that is not strongly bound [17].

Average value of Aw chicken liver meatballs with gelatin is in the range of 0.88-0.90. Meatballs are animal product that has pH value around 6.0-6.5 and Aw value >0.9 [18], while chicken liver meatballs with gelatin at different levels have Aw value of T0 0.88 ± 0.02; T1 0.88 ± 0.03; T2 0.88 ± 0.03; T3 0.90 ± 0.02. Magnitude of Aw value greatly affecting the shelf life of meatballs. Water activity can affect the ability of microbes to grow and develop. The lower the water activity in the meatballs, the smaller total microbes can live.

The highest Aw value was found in the T3 treatment 0.90 ± 0.02 while the smallest Aw value was found in the T0 treatment 0.88 ± 0.02. Addition of filler can reduce the Aw value of meatballs. The additional tapioca flour in large amounts causes a decrease in water activity of the meatballs due to the enhancement of bound water so free water decreases. Starch added during meatball production can bind water which causes free water to enter the granule and bond with starch. This binding takes place during the heating or cooking process of the meatballs [19].

3.3 Water Content

Water content is one of the main characteristics of food. Water content in food products has an impact on appearance, texture, color, shelf life, freshness, and taste. The results showed that additional gelatin with different levels had no effect (P>0.05) on the water content of chicken liver meatballs. The amount of flour, liquid, and the type of protein used in the meatball mixture have an impact on the water content of the meatball product. Flour can be used as a binder so it can bind a certain amount of water in the meat which causes low water content in meatballs [20].

According to SNI 3818 : 2014, the water content in meatballs does not exceed 70%, while chicken liver meatballs with the addition of gelatin have water content value (T0) 69.00% ± 1.87; (T1) 68.38% ± 3.09; (T2) 66.50% ± 2.65; (T3) 64.38% ± 2.10. Chicken liver meatballs with additional gelatin comply with the required standard. Heating process in meatballs production causes the amount of absorbed water to escalate due to diffusion water process into meatballs and eventually forms bonds with protein and starch. Starch has many hydroxyl (OH) group bonds so it is able to absorb or bind a lot of water [21].

The highest percentage of water content was found in the P0 treatment, 69.00% ± 1.87, while the smallest water content value was found in the P3 treatment, 64.38% ± 2.10. The higher percentage of gelatin added led to reduction of water content. This process is caused by the fact that gelatin can bind large amounts of water, which is 5-10 times the weight of gelatin [22]. The content of amino acids in gelatin affects the ability of gelatin to bind/absorb water. Gelatin has amino acids hydroxyproline and proline that have the ability to bind water because they have carbonyl and hydroxyl groups that can form hydrogen bonds.

3.4 Randement

Randement is the ratio of the final weight of cooked meatballs to the weight of raw meatballs. The results showed that chicken liver meatballs with the addition of gelatin at different levels had no effect (P>0.05) on the yield value of chicken liver meatballs. Additional filler to the dough during meatball production affecting the randement value. Randement value can be increased by adding ice cubes during production and due to meat having the capacity to bind water both outside and inside the meat [24].

The calculation of randement is used to determine how much of the meat that can be utilized into food products. The greater randement value, the higher economic value of the product. The amount of water lost during heating process affects the final randement. Processing, worker expertise, and handling in the production need to be done precisely and also carefully, if the production is carried out carelessly it can causes the product with a small randement value [25].

The highest randement value was obtained in the P3 treatment 100.20% ± 1.86, while the smallest randement value was obtained in the P0 treatment 94.04% ± 0.90. Meatballs with additional high salt concentration can increase the randement value. Salt can weaken the interaction between protein groups of different charges so led to escalation of protein solubility, protein plays a role in binding water which causes the randement value to increase [16].

4 Conclusion

The additional of gelatin with different level concisted of 0%, 3%, 6%, and 9%. It did not affect the WHC, Aw, water content, and randement values of chicken liver meatballs. The average results of WHC in each treatment are 46.39- 49.24%, Aw: 0.88 - 0.90, water content: 69 - 64.37%, and randement: 94.04 - 100.20%. The best treatment of gelatin addition to

broiler chicken liver meatballs is in the treatment with 9% gelatin addition in terms of WHC value 49.24%, Aw 0.90, water content 64.38%, and randement 100.20%.

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