Quality of Chicken Meat Which is Given Treatment of Electric Stimulation

Nuraini¹, Iva Armila¹, Harapin Hafid¹*, and Siti Hadrayanti Ananda²)

¹ Faculty of Animal Science, Halu Oleo University, Jl.HEA. Mokodompit Kampus Bumi Tridarma Anduonohu, Kendari 93232 South East Sulawesi Indonesia

² Nutrition Study Program, STIKES Karya Kesehatan, Anduonohu, Kendari 93232 Southeast Sulawesi, Indonesia

*Corresponding Author: harapinhafid14@gmail.com

Abstract. This study aims to investigate the extent to which electrical stimulation affects the quality of native chicken meat. The study was designed using a complete randomized design with four treatments consisting of 20 Volts / 0 minutes (as controls), 20 Volts / 2 minutes, 20 Volts / 3 minutes and 20 Volts / 4 minutes. The parameters observed were shrinkage cooking shrinkage, meat pH, flavor, color, texture and tenderness. The results showed that physically stimulating electricity for two minutes significantly affected the lowest cooking shrinkage compared to the duration of stimulation compared to other stimulations. Electrical stimulation does not affect the pH of meat. The treatment of electrical stimulation significantly affected the organoleptic properties of chicken meat, where the flavor of the meat was favored by the panelists at three minutes of stimulation, as well as the aroma, texture and very apparent tenderness. Color parameters are not affected by electrical stimulation. It was concluded that the two to four minute electrical stimulation treatment with 20 Volt strength had a very significant effect (p <0.01) on cooking losses, tenderness and significantly affected (p <0.05) on taste, aroma and texture of native chicken meat.

Keywords: Electrical Stimulation, Meat Quality, Native Chicken

1. Introduction

Chicken meat is one of the meats used by the community both in the form of meat and processed products. Chicken meat is quite popular because it has a good taste, distinctive aroma, more supple and muscular, not soft and low in broiler chicken meat. However, free-range chicken has meat that is very difficult to digest by the beneficial body in the thigh. Therefore, a method is needed that can increase the tenderness of native chicken meat by electrical stimulation. Livestock age has a large influence on meat quality, especially on tenderness. The older the age of livestock, the higher the number of cross-linking of collagen fibers, so that meat tends to be more difficult than younger animals. Another cause of meat weakness is postmortem muscle shortening, shortening of this muscle can be reduced or prevented by means of carcassing after cutting. Various techniques have been developed and introduced to overcome meatiness such as electrical stimulation, marination, and a combination of these two methods [1][2]. Electrical stimulation is one way to increase meat tenderness. The treatment of electrical stimulation in handling meat after slaughter has been reported
by researchers that can affect the quality of meat [3][4]. Electrical stimulation will accelerate the process of postmortem glycolysis that occurs during the conversion of muscle to meat, thus accelerating the rate of crossing of actin myofilament and myosin in the rigormortis process [5]. Electrical stimulation can change the characteristics of meat palatability so that it becomes tender and the texture becomes more tight. Electrical stimulation of carcasses has been shown to reduce postmortem pH, increase meat tenderness, accelerate the rate of postmortem glycolysis and prevent muscle shortening due to cold temperatures [5]. By getting electrical stimulation treatment with a voltage of 20 volts/2 minutes can increase tenderness, color, and texture of duck meat. The aim to be achieved from this study is to study the long-lasting effect of electrical stimulation on the quality of native chicken meat [6].

2. Methods
The research was conducted at the Laboratory of the Department of Animal Husbandry, Faculty of Animal Husbandry, Halu Oleo University, Kendari. The equipment used in this study consisted of a knife, plate, fork, 20 volt power supply, thermometer, plastic politelin, tissue, pH brand Hanna instrument, 100 ml cup glass, basin and stationery. The material used in the study was 100 ml aquades and male chicken meat aged 1.5 to 2 years were 12 head. The compression instrument used is an electrical stimulation device with a voltage of 20 volts with a stimulation time of 0 each (control), 2, 3 and 4 minutes with 3x each. The stimulation method is to connect the two positive and negative electric poles to the chicken meat sample. Sampling is done by separating the thighs from the body of the cattle. Sample determination is done by cutting on the thigh. Without differentiating left and right thighs. Prior to the main research, preliminary research was carried out to avoid unwanted mistakes when the main research was conducted. All treatments were systematically applied and repeated three times each. Then the sample is put into polyethylene plastic to get organoleptic testing and labeled. The label given is adjusted to the treatment code applied, then folded lengthwise and pressed so that there is no direct contact with water when boiled.

2.1 Research variable
The variables observed in this study are physical properties and organoleptic properties of meat as follows.

2.1.1 Physical Properties Test
- **Cooking Loss** is measurement of cooking shrinkage [1] was carried out on meat samples which were cooking at 80°C for 60 minutes, then cooled at room temperature and then cooled at a low temperature of ± 0°C. After that the meat sample is wiped with tissue paper to absorb water on the surface of the meat, then the sample is weighed. Value of meat cooking losses is calculated by following formula:

\[
\text{reduction (cm)} = \frac{\text{weight before cooked} - \text{weight after cooked}}{\text{weight before cooked}} \times 100\%
\]

- **Testing** the pH of the meat was done using Bouton method [7][1], that is a sample of 10 g of meat is mashed and then mixed with 10 ml of aquadest then stirred until homogeneous. The pH meter is cleaned with distilled water and a pH 7 buffer is put in place to adjust the pH. Every pH of the solution was measured three times and the results were calculated as the pH value of the meat.

2.1.2 Test for Organoleptic Properties
Organoleptic test is testing a material or product based on preference (Hedonict Test) [6]. Testing of panelists using the response of likes or dislikes about the nature of the experimental products tested was the long influence of electrical stimulation on the quality of native chicken meat, with the number of semi-trained panelists of 30 persons [8]. Faculty of Animal Husbandry students in the category of
untrained panelists. The hedonic scale for organoleptic tests includes taste, aroma, color, texture, and tenderness (Table 1).

| Variable | Scale | Criteria          | Variable | Scale | Criteria  |
|----------|-------|------------------|----------|-------|-----------|
| Taste    | 1     | Very Good        | Texture  | 1     | Very Soft |
|          | 2     | Good             |          | 2     | Soft      |
|          | 3     | Pretty Good      |          | 3     | Medium    |
|          | 4     | Not Good         |          | 4     | Rough     |
|          | 5     | Not So Good      |          | 5     | Very Rough|
| Aroma    | 1     | Very Good        | Tenderness| 1   | Very Tender|
|          | 2     | Good             |          | 2     | Tender    |
|          | 3     | Pretty Good      |          | 3     | Medium    |
|          | 4     | Not Good         |          | 4     | Hard      |
|          | 5     | Not So Good      |          | 5     | Very Hard |
| Color    | 1     | White            |          |       |           |
|          | 2     | Pale White       |          |       |           |
|          | 3     | Pink             |          |       |           |
|          | 4     | Red              |          |       |           |
|          | 5     | Maroon           |          |       |           |

*Source: [6][4].

2.2 Research Design

The design used in this study is Completely Randomized Design, with 4 treatments 3 replications for physical quality testing, and using 30 panelists as replications for testing the organoleptic quality of each treatment is as follows:

L0 = Without Electrical Stimulation (Control)
L1 = 2 Minutes of Electric Stimulation with a voltage of 20 Volts
L2 = 3 Minutes of Electric Stimulation with a voltage of 20 Volts
L3 = 4 Minutes of Electric Stimulation with a voltage of 20 Volts

2.3 Data Analysis

The data obtained were analyzed based on variance analysis. The treatment that affects the variables is carried out further testing with the Least Significant Difference Test [9].

3. Result and discussion

The average percentage of cooking loss, pH, taste, aroma, color, texture and tenderness of chicken meat stimulated by electricity are presented in Table 2.

| Variable       | Electric Stimulation Duration | L0 (0 menit) | L1 (2 menit) | L2 (3 menit) | L3 (4 menit) |
|----------------|-------------------------------|--------------|--------------|--------------|--------------|
| Cooking loss   | 20.10,±0,69                  | 21.0,±1.50   | 21.20,±1.18  | 23.5,±0,90   |
| pH             | 5.66±0,17                    | 5.55±0,19    | 5.41±0,10    | 5.47±0,15    |
| Taste          | 3.52,±0,25                   | 2.93,±0,23   | 2.45,±0,23   | 2.05,±0,13   |

Table 2. Average Percentage of cooked chicken meat with electric stimulated
Based on the analysis of variance in Table 2 shows that the treatment of electrical stimulation in male native chickens up to 4 minutes had a very significant effect (p <0.01) on the cooking loss of free-range chicken. It is known that the average cooking loss of male chickens is 20.10 - 23.5%. The value of cooking loss in male chicken meat has excellent meat quality because the cooking loss value obtained includes a low of 35%. Meat that has a low cooking loss value below 35% is of good quality because of the possibility of the release of meat nutrients during cooking is also low [10]. The low content of cooking loss will make the quality of meat good. Based on the results of the smallest significant difference test showed 20 volt electrical stimulation treatment had a very real effect, the results of the BNT further test showed 2 minutes and 4 minutes treatment had a significant effect [1]. This is presumably because the meat stimulated with greater stress and duration causes greater temperature rise and results in damage to protein filaments and larger muscle fiber structures so that the protein loses the ability to bind fluid and meat structure to be looser than with stimulated meat using lower stresses and stimulation times. The average cooking shrinkage value significantly affected the duration of electrical stimulation 0 minutes, 1 minute and 2 minutes minutes respectively 11.27%, 14.39% and 14.78% with a voltage of 90 V [6][11]. Cook cook during cooking is affected by the binding capacity of water from the meat tissue and the fat content in or on the meat surface [1].

### 3.2 pH

Based on the analysis of variance in Table 3 shows that chicken meat stimulated by electricity did not have a significant effect (p> 0.05) on pH. The average pH value of native chicken meat obtained ranged from 5.41 to 5.66%. This value is still normal. This is in accordance statement stating that a decrease in the pH value in the postmortem muscle is largely determined by the rate of postmortem glycolysis and muscle glycogen reserves of meat, normally from 5.4 to 5.8 [1]. Whereas according to Lawrie states that animal muscle tissue at the time of life has a pH value of about 5.1 to 7.2 and decreases after cutting because it experiences glycolysis and lactic acid is produced which will affect the pH, the ultimate normal pH of postmortem meat is around 5, 5 [10]. Changes in pH after livestock die are basically determined by the content of lactic acid buried in the muscle which is then determined by glycogen content and treatment before slaughter [12]. The decrease in muscle pH is caused by the presence of glucose glycolysis activity anaerobically broken down into lactic acid. The results of variance analysis showed that the treatment given to chicken meat stimulated by electricity had a significant effect (p <0.05) on the taste of native chicken meat. BNT test results showed that 4 minutes treatment (2.05) gave the best score from other treatments. This is in line with the results of a study before that laying hens which have been electrically stimulated with different stresses have a relatively similar taste or flavor [12], so that the acceptability of the meat of the layer laying hens is also not significantly different. In this case, the panelists’ acceptance of meat products from the laying hens ranged from somewhat like to like. Electrical stimulation has a very real effect on the taste in meat, this can be caused by the cooking factor of meat and the age of livestock that are more mature and fat, so the taste of meat will grow. According to the statement that stating the taste of meat will increase during meat cooking and is influenced by a lot of fat [1][13].

### 3.3 Aroma

Scent is a state of meat that can be detected by the sense of smell that determines the condition of the meat either or not. Based on variance analysis showed that the electrical stimulation treatment had a significant effect (p <0.01) on the aroma of native chicken meat. BNT 1% test results showed that the

| Aroma     | 3.30±0.36 | 2.63±0.03 | 2.53±0.37 | 2.03±0.06 |
|-----------|-----------|-----------|-----------|-----------|
| Color     | 2.68±0.03 | 2.82±0.06 | 2.68±0.03 | 2.78±0.35 |
| Texture   | 3.13±0.08 | 2.50±0.58 | 2.20±0.43 | 1.92±0.21 |
| Tenderness| 4.00±0.09 | 2.62±0.16 | 2.08±0.10 | 1.73±0.06 |

*Different superscripts on the same line show very real differences (P<0.01)
electrical stimulation treatment with a voltage of 20 Volts in 4 minutes treatment (2.03) gave the best score but was not significantly different from treatment 2 and 3 minutes, and was significantly different (P <0.01) with treatment 0 and 2 minutes. In general, aroma is influenced by cooking and age of livestock. The common factors that influence the aroma of meat are age and temperature of cooking [1]. Study states that many aromas are determined by precursors which are soluble in water and fat and the release of volatile substances (volatiles) contained in meat.

3.4 Color
The factor that influences the determinants of meat color is the concentration of myoglobin meat pigment. Based on the results of variance analysis showed that the electrical stimulation treatment had no significant effect (p> 0.05) on the color of native chicken meat. This is because muscle activity affects the color of the muscles, the thigh muscles have a darker color than the chest muscles, because the thighs have more stress to stand and support the body than the chest. Besides that, the chicken nation also affects muscle structure, in muscle broilers it is brighter in color and larger in diameter than laying hens [14]. Based on the results of further tests BNT 1% showed that electrical stimulation with a voltage of 20 Volts in treatment 2, 3, and 4 minutes was not much different from the results obtained 0 minutes that were not given electrical stimulation treatment. This is due to electrical stimulation in the carcass can cause bright red muscle color, muscle compactness and marbling solidification develop faster than non stimulation [1].

3.5 Texture
Texture is the roughness of the flesh associated with meat muscle fibers. The older the age of the animal, the more rough the meat texture. Based on the results of variance analysis showed that the electrical stimulation treatment had a significant effect (p <0.05) on the texture of native chicken meat. BNT 1% test results showed that treatment 3 and 4 minutes had a good effect and had a significant effect (p <0.05) with treatment 0 and 2 minutes. This is due to the influence of electrical stimulation which is able to divide the bonds of large muscle fibers bounded by the perimiseal septum into fine fiber bonds. The roughness of the meat texture can increase with increasing age of livestock. The young cattle connective tissue contains reticulins and crosslinking is lower than the collagen of the older connective tissue of cattle [2]. Muscles with small muscle fibers do not show texture roughness significantly by increasing age. In general, male cattle muscles have a coarser texture than female cattle muscles. Farmers also affect muscle texture. The young cattle connective tissue contains reticulins and crosslinking is lower than collagen connective tissue of older cattle [1].

3.6 Tenderness
Meat tenderness and texture are the most important determinants of meat quality. Consumers prefer soft meat because it is easier to process and more appetizing [1]. Based on the results of variance analysis showed that the electrical stimulation treatment had a very significant effect (p <0.01) on chicken meat tenderness. BNT 1% further test results showed that 4 minutes treatment (1.73) gave very good results on meat tenderness of male native chickens compared to 0 minutes (4.00), 2 minutes (2.62) and 3 minutes (2.62). This causes the provision of electrical stimulation that can break down protein molecules into smaller amino acid molecules and also damage chemical bonds in the meat so that the meat becomes soft and electrical resistance is a contributing factor in determining differences in meat tenderness. In line with previous statement, the longer the electrical stimulation [1], the more the meat tenderness increases. This is due to the longer stimulation, the greater the glycolysis that occurs and causes more lactic acid formed. The formation of a lot of lactic acid will also cause a large decrease in pH. This will cause protein denaturation and meat structure to become more tender. Reported the influence of electrical stimulation on carcass of sheep, Similarly reported a shear force value of meat that was electrically stimulated 10% lower than that which was not stimulated (10% more tender). Similarly reported that electrical stimulation voltage affects softness beef [15][16][17].
4. Conclusion
Based on the results of the study it can be concluded that the electrical stimulation treatment with a voltage of 20 volts can improve the quality of chicken meat including taste, aroma, texture and tenderness in the thigh meat.

5. Reference
[1] Soeparno. 2009. Ilmu dan Teknologi Daging. Cetakan ke lima. Gadjah Mada University Press. Yogyakarta.
[2] Hafid, H. 2017. Pengantar Pengolahan Daging. Cetakan Pertama. Penerbit Alfabeta, Bandung.
[3] Ho, C. Y., M. M. Stromer & R. M. Robson. 1996. Effects of electrical stimulation on postmortem titin, nebulin, desmin, and troponin-t degradation and ultrastructural changes in bovine longissimus muscle. J. Anim. Sci. 74:1563-1575.
[4] Lee, S., P. Polidori, R. G. Kauffman & B. C. Kim. 2000. Low-voltage electrical stimulation effects on proteolysis and lamb tenderness. J. Food. Sci. 65: 786-790.
[5] Aberle, E.D., J.C. Forest. H.B. Hendrick. M.D. Judge. and R.A Merkel. 2001. Principle Of Meat Science.W.H. Freeman and Company. San Fransisco.
[6] Hafid H., Nuraini dan Inderawati, 2014. Sifat organoleptik daging itik afkir yang diberi perlakuan stimulasi strik, Prosiding Seminar Nasional Optimalisasi Sumber daya lokal pada Peternakan Rakyat Berbasis Teknologi. Fakultas Peternakan Universitas Hasanuddin. Makassar. 182–193.
[7] Bouton, P. E., P. V. Harris, and W. R. Shorthose. 1971a. Effect of ultimate Ph upon the water-holding capacity and tenderness of mutton. J. Food Sci. 36:435-439.
[8] Suryati, T., M. Astawan & T. Wresdiyati. 2006. Karakteristik organoleptik daging domba yang diberi stimulasi listrik voltase rendah dan injeksi kalsium klorida. Media Peternakan. 29(1):1-6
[9] Hafid, H. and A. Syam. 2007. Pengaruh aging dan lokasi otot terhadap kualitas organoleptik daging sapi. Buletin Peternakan 31(4): 209 – 217
[10] Gaspersz, V. 1991. Metode Rancangan Percobaan. Metode Perancangan Percobaan Untuk Ilmu-ilmu Pertanian, Ilmu-ilmu Teknik dan Biologi. Penerbit Armico. Bandung
[11] Yanti, H., Hidayati, dan Elfawati. 2008. Kualitas daging sapi dengan kemasan plastik PE (polyethylen) dan plastik PP (polypropylen) Di pasar arengka kota pekanbaru. Jurnal Peternakan. 5 (1) : 22 – 27.
[12] Syam, A. Soeparno and Rusman. 2013. Efek lama stimulasi dan tegangan listrik terhadap komposisi kimia, kualitas fisik dan sensori daging ayam petelur afkir. Buletin Peternakan. 37 (1): 26-33.
[13] Buckle, K.A., R.A. Edwards, G.A. Fleet, and M. Wooton. 2007. Ilmu Pangan. Terjemahan Hari P. dan Adiono.Universitas Indonesia Press. Yogyakarta.
[14] Prasetyo, E., A.M.P. Nuhiawangsa dan W. Swastike., 2012, Pengaruh lama perebusan terhadap kualitas kimia dan organoleptik abon dari bagian dada dan paha ayam petelur afkir. Sains Peternakan. 10 (2) ::108-114
[15] Davel, M., M.J.C. Bosman and E.C. Webb. 2003. Effect of electrical stimulation of carcasses from Dorper sheep with two permanent incisors on the consumer acceptance of mutton. South African Journal of Animal Science 2003, 33 (3): 206-212.
[16] Kim, Yong S., Chin N. Lee, Michael W. DuPont, and Glen K. Fukumoto. 2007. Improving tenderness of forage-finished beef using a low-voltage electrical stimulator. Food Safety and Technology 22 Jan 2007. P.1-6.
[17] Khasrad, Sarbaini, Arfafl and Rusdiansyah. 2018. Effect of post-mortem electrical stimulation on meat quality of pesisir cattle (indigenous cattle of west sumatera). Pakistan Journal of Nutrition. 17 (9): 441-445