Physical meat quality comparison of selected KUB chicken, original Kampung and improved Kampung chicken with in ovo feeding technology

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Abstract. The purpose of this study was to determine the comparison of the quality of native chicken meat. The study used 90 Day old chicken (DOC) three types of native chickens. Chickens were reared for 70 days with ad libitum feeding and drinking water. The method used was a completely randomized design (CRD) with 3 treatments and 15 replications. The treatments were P1 (native native chicken, Balitnak superior (KUB)), P2 (ordinary native chicken) and P3 (native chicken in ovo feeding breeds). The parameters measured were the pH value of the meat, water binding capacity, cooking losses, tenderness, and meat color. Research data obtained at pH values P1 (5.92), P2 (5.95), P3 (5.58); water holding capacity (%) P1 (42.6), P2 (37.27), P3 (5.58); cooking losses (%) P1 (18.46), P2 (19.46), P3 (24.86), tenderness (kg/cm²) P1 (0.74), P2 (0.76), P3 (0.94); flesh color L P1 (56.04), P2 (56.60), P3 (54.04), meat color a P1 (5.91), P2 (5.93), P3 (3.82); and meat color b P1 (5.93), P2 (5.98), P3 (5.45). The results showed that although there were differences in pH, water holding capacity, and cooking losses in all treatments, the three of them were still of good quality meat because they had pH values that were still in the normal range and the meat was very tender.

1. Introduction

Native chickens play an important role in meeting animal protein needs and side income for rural communities. Its products in the form of eggs and meat have a savory taste, delicious and in demand by the public. In addition to the meat that has a savory and tasty taste, native chicken meat is also known to be tough. The slow growth caused the maintenance period of native chickens to become longer which eventually impacted the tough meat.

To prevent tough native chicken meat, it is necessary to increase its good performance by improving the quality of feed, maintenance management and improving genetic quality. Improving the genetic quality of native chickens can be done by using in-ovo feeding technology and breeding selection. The use of in ovo feeding technology to improve the performance of native chickens has been carried out by [1,2]. Meanwhile, the native chickens that have undergone a selection process of breeding to improve their performance are the native chicken Balitnak (KUB) Bogor. Therefore, in this study, the objective of this study was to compare the quality of the meat between the superior native village chicken Balitnak (KUB), original native chicken, and in ovo feeding native chicken.
2. Material and methods
The research was conducted from October 2019 to June 2020. The research was conducted in CV. Bittara Wanua in Soppeng Regency and the Laboratory of Animal Products Technology Hasanuddin University, Makassar.

Total 90 DOC of native chickens were placed in 3 brooding cages with litter mats measuring 1.5 x 1 meter based on each type of native chicken treatment. Before use, the brooding cage is first sprayed with disinfectant using a sprayer. Each brooding cage is filled with 30 mixed sex DOC. Each brooding cage is equipped with an incandescent lamp for heating, a cover cloth, a place for feeding, and a place for drinking. After 3 weeks of age, the chickens are transferred to rearing cages, each measuring 2 x 2 meters, equipped with litter mats, fluorescent lamps, feeding containers and drinking containers. During the maintenance period, the source of drinking water used is well water that has been chlorinated in advance and is given ad libitum and is replaced every morning and evening. The feed used is the commercial feed brand 8202 SP from the feed company PT. Malindo Feedmill Tbk. which has a composition of feed ingredients consisting of yellow corn, soybean meal, fine bran, fish meal, meat meal, pollard, stone flour, DCP, salt, CPO, mineral premix, vitamin premix, and antioxidants with total nutritional content as shown in Table 1 and administered ad libitum. Vitamins are given to chickens through drinking water at the age of 1 week. At the age of 4 days, vaccination through eye drops and injection is carried out. The study used 3 treatments and 15 replications (15 chickens were taken randomly from 30 chickens). The treatments were P1 (KUB native chicken), P2 (original native chicken), and P3 (native chicken in ovo feeding).

Table 1. Feed Nutritional Content of feed (8202 SP).

| Nutrition | %          |
|-----------|------------|
| Protein   | 20–22      |
| Fiber     | 4          |
| Fat       | 5          |
| Water     | 13         |
| Ash       | 7          |
| Calcium   | 0.9–1.1    |
| Phosphorus| 0.6–0.9    |
| Aflatoxin | 40 ppb     |

* Results of the analysis of PT. Malindo Feedmill Tbk.

The parameters for the performance test include the pH value of the meat, the water holding capacity, cooking losses, tenderness, and meat color. Measuring the pH of meat using [3] method by inserting a pH meter into the middle of the muscle with a depth of 0.5 to 1 cm below the surface of the muscle.

The water holding capacity is determined by calculating the free water content in the meat. The measurement uses the "Rapid filter paper method". This method relies on the capillary suction force of filter paper that is placed on the surface of the meat. It is very fast and involves placing the filter paper on the freshly cut surface at a specified time after cutting (for example, 10 minutes), straightening it, then scoring the filter paper to determine the level of wetness (0–100% wet) or weighing the filter paper [4].

Measurement of cooking losses using a meat sample of about 100 grams. The meat sample is boiled until the temperature in the meat reaches 81°C. The sample is removed, drained and cooled until its weight is constant. The percentage of cooking losses is calculated using a formula [5].

Measurement of meat tenderness by calculating the amount of strength (kg/cm²) needed to cut the core of the meat indicated by the pointer of the Warner Bratzler Shear Force meat cutter with a sensitivity scale of 0.1 kg/cm². Measuring the color of chicken meat using a Chroma meter (Konica Minolta, model CR 410, Japan). The color is expressed as L* (brightness), a* (reddish) and b* (yellowish).
The data obtained in the study were analyzed for variance based on a completely randomized design (CRD) using the SPSS 16 application. Different treatments were further tested using the Duncan advanced test. A probability level of $P < 0.05$ was considered as significantly different.

3. Results and discussion

The results of the research on the quality of the meat of three types of native chicken are presented in table 2. The results of the analysis showed that the parameters that were significantly different ($P < 0.05$) were shown in the pH value, water holding capacity, cooking loss, tenderness and meat color $b^*$. The pH value of KUB chickens was 5.92, native chickens were 5.95 and in ovo native chickens were 5.58; water binding capacity (%) in KUB 42.6, native chickens 37.27 and native chickens in ovo 51.78; cooking losses in chickens 18.46, original native chickens 19.46 and native chickens in ovo 24.86; tenderness in KUB chickens 0.74, original native chickens 0.76 and native chickens with in ovo breeds 0.94; color of meat $L^*$ in chicken KUB 56.04, free-range chicken original 56.60 and native chickens in ovo 54.04; Color of meat $a^*$ in KUB chickens 5.91, native chickens 5.93, and native chickens in ovo 3.82; color of $b^*$ meat in KUB 5.93 chickens, 5.98 original free-range chickens and in ovo native chicken 5.45.

| Parameter                  | Type of native chicken | P-Value |
|----------------------------|------------------------|---------|
| pH                         | KUB 5.92               | Original 5.95 | In ovo feeding 5.58 | 0.000 |
| Water holding capacity (%) | 42.6$^a$               | 37.27$^a$ | 51.78$^b$ | 0.000 |
| Cooking loss (%)           | 18.46$^a$              | 19.46$^a$ | 24.86$^b$ | 0.000 |
| Tenderness (kg/cm$^2$)     | 0.74$^a$               | 0.76$^a$ | 0.94$^b$ | 0.012 |
| Meat colour $L^*$          | 56.04                  | 56.60 | 54.04 | 0.663 |
| Meat colour $a^*$          | 5.91$^a$               | 5.93$^a$ | 3.82$^b$ | 0.000 |
| Meat colour $b^*$          | 5.93                   | 5.98 | 5.45 | 0.549 |

$^a,b$: Different superscripts following the mean value on the same row indicate significant differences ($P < 0.05$).

3.1. pH value

The highest average pH values were regular native chicken 5.95, KUB chicken 5.92, and 5.58 in ovo feeding native chicken. The average pH value obtained is still within the normal pH range. The normal pH value of chicken meat ranges from 5.96 to 6.07 [3]. The pH value of in ovo native chicken meat differed significantly from other treatments and had the lowest value due to the difference in storage time after slaughter. The storage time for in-ovo feeding native chicken meat is longer than that of KUB chicken and regular native chicken.

The decrease in pH is directly proportional to the length of storage time. The longer the storage time, the lower the pH value, this is due to the reduced glycogen reserves in muscle tissue. Decreased glycogen reserves cause the lower lactic acid content which results in a decrease in the pH of the meat. This is in line with [6] who stated that the rate of pH reduction is related to the amount of glycogen in muscle, muscles that have low total glycolytic potential also show a low pH reduction rate.

3.2. Water holding capacity

The results showed that the water holding capacity of the highest was in ovo feeding native chicken 51.78, KUB 42.6 chicken and native chicken could be 37.27. The water holding capacity of the in ovo feeding native chicken meat was significantly higher than that of KUB chicken and regular native chicken because of differences in meat maturation time and health problems during maintenance. The results obtained are in accordance with the results of research by Qiao et al (2001) which showed that high pH values have low water holding capacity and vice versa [7]. The cause of the high water
holding capacity in native chicken meat in ovo is thought to be due to the length of maturation. The maturation time (aging) affects the water holding capacity, the longer the maturation time, the higher the water holding capacity [8]. The increase in water holding capacity in the maturation process occurs due to an increase in charge through the absorption of K+ ions and the release of Ca2+ or due to weakening of the myofibril bonds when there is a change in the relationship between water and protein in meat [9].

3.3. Cooking loss
The highest average value of cooking losses was in ovo feeding native chicken at 24.86%, original native chicken 19.46% and KUB chicken 18.46%. Purslow et al [10] stated that the cooking losses of meat were in the range of 18.7%–27.4%. In ovo feeding native chicken meat has a higher cooking loss and is significantly different from that of KUB chicken and regular chicken. This difference is caused by differences in storage time and pH values. The cooking loss value is lower for meat with a high pH compared to normal pH and low pH [11] or in other words, meat with a high pH value has a low cooking loss and vice versa.

The length of time that the meat is stored will decrease the pH value and will have an impact on increasing the percentage of cooking implants. This is in accordance with Risnajati (2010) which states that in line with the decrease in pH due to storage time will cause protein denaturation due to proteolytic enzyme activity [12]. The factors that influence cooking loss are the pH value, the length of the muscle fiber sarcomere, the contraction status of myofibril bonds, the size and weight of the meat sample, the cross-section of the meat, heating, nation, meat fat, age, and energy consumption in feed [13].

3.4. Tenderness
The highest average values for tenderness were native chicken in ovo feeding 0.94 kg/cm², original native chicken 0.76 kg/cm², and KUB chicken 0.74 kg/cm². The results of the analysis showed that there was a significant difference between the tenderness value of the native chicken in ovo with the tenderness value of the common native chicken and KUB. Although the three treatments had significant differences, they were included in the very tender meat category.

Shackelford et al [14] stated that meat tenderness can be divided into 7 parts, namely very soft has a breaking strength Warner Blatzer <3 kg/cm², soft 3–4 kg/cm², quite soft 4–5 kg/cm², slightly soft 5–6 kg/cm², rather tough 6–7 kg/cm², quite tough 7–8 kg/cm², and tough >8 kg/cm². Meat tenderness is influenced by several factors, namely factors before cutting (antemortem) and after cutting (postmortem). Antemortem factors include genetics, management, species, livestock physiology, and age, while postmortem factors include withering, freezing, processing methods, and the addition of tender material [15]. Withering at 4°C for a week causes an increase in tenderness due to a decrease in the pH of the meat which triggers the cathepsin enzymes to become active and can break down meat protein [16].

3.5. Meat Color
The results of the measurement of meat color showed a significant difference in a* (redness) between KUB chickens and original native chickens against in ovo native chickens. However, L* (brightness) and b* (yellowish) did not show a significant difference between all treatments. The brightness, redness, and yellowish values of KUB chicken were 56.04; 5.91; 5.93, for original native chickens, namely 56.60; 5.93; 5.98, and in ovo feeding native chickens, namely 54.04; 3.82; 5.45. Meat color in all treatments tended to be pale because it had a high L* value (>53) and was included in the PSE meat color category (pale, soft, exudative). Qiao M et al., (2001) grouped the color of broiler chicken based on its L* value, namely DFD (dark, firm, dry) meat if the L* value was lower than 46, normal meat if the L* value was between 48–53 and PSE meat (pale, soft, exudative) if the L* value is more than 53 [7].
The redness ($a^*$) value of native chicken meat in ovo was lower than the other two treatments. This is because at the end of the maintenance period the native chickens in ovo experience health problems that cause stress. This is in line with [17] who stated that a decrease in the redness ($a^*$) value occurred in stressed chickens because more myoglobin was oxidized in their muscles. The reddish value of meat also depends on the pH of the meat, a low pH value will consistently decrease the redness value, which causes redox reactions of myoglobin and haemoglobin [18].

4. Conclusion
In ovo feeding chicken meat is different from other treatments in terms of pH value, water holding capacity, cooking loss, and tenderness. Even so, the three types of native chicken meat have good quality because they have a normal pH and are classified as very tender meat.

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