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[1]Department of Animal Science, Bangladesh Agricultural University, Mymensingh-2202.

***Corresponding Author:**

MA Hashem
E-mail: hashem_as@bau.edu.bd

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Research Article

Can live and dead broiler meat be identified through sensory and physicochemical attributes?

MA Hashem[1]*, SM Islam[1], ZH Tushar[1], MH Rahaman[1] and S Akhter[1]

Abstract

The study was conducted to identify live and dead broiler meat through sensory and physicochemical attributes at 0 h and 24 h intervals. For this purpose, 15 live and 15 dead broilers were collected from the local market. After deboning, each live and dead bird's breast, thigh, and liver were collected. A 2 × 2 factorial experiment was used for data analyses. Samples were preserved at 40C for 24 hrs. Different types of analysis, such as sensory (color, flavor, tenderness, juiciness, overall acceptability), physicochemical properties (pH, cooking loss, drip loss, water holding capacity), and instrumental color value L*, a*, b* were determined. In the case of breasts, sensory attributes like color, flavor, tenderness, juiciness, and overall acceptability mean value decreased (3.80 to 1.70) significantly ($p<0.05$) between live and dead birds and the mean value also decreased (3.50 to 2.00) significantly ($p<0.05$) at 0 h and 24 h. On the other hand, the physicochemical attributes and instrumental color values like water holding capacity, L*, a*, SI and Chroma mean value decreased significantly ($p< 0.05$) between live and dead birds, and the mean value of pH, drip loss, water holding capacity, and chroma also decreased significantly ($p< 0.05$) at 0h and 24h. In the case of the thigh, sensory attributes like color, flavor, tenderness, juiciness, and overall acceptability mean value decreased (4.90 to 1.70) significantly ($p<0.05$) between the two treatment levels, and there is no significant difference ($p<0.05$) in term of mean value at 0h and 24h of intervals. On the other hand, the physicochemical attributes like pH, water holding capacity, L*, a*, b*, SI, and chroma mean value decreased significantly ($p< 0.05$) between the two treatment levels, and the mean value of water holding capacity, a*, b*, SI, chroma also decreased significantly ($p< 0.05$) at 0 h and 24 h. In the case of the liver, sensory attributes like color, flavor, tenderness, juiciness, and overall acceptability mean value decreased (4.90 to 1.00) significantly ($p<0.05$) between the two treatment levels, and the mean value of color, tenderness, juiciness, overall acceptability also decreased (3.40 to 2.80) significantly ($p<0.05$) at 0h and 24h. On the other hand, the physicochemical attributes like pH, cooking loss, L*, b*, SI, and chroma mean value decreased significantly ($p< 0.05$) between the two treatment levels, and the mean value of cooking loss, drip loss, water holding capacity, a*, SI, chroma also decreased significantly ($p<0.05$) at 0h and 24h. On the basis of the sensory and physicochemical attributes, live broiler breast, thigh, and liver in fresh condition showed better quality. For differentiation, color, flavor, tenderness, juiciness, water holding capacity, L*, a*, b*, SI, and chroma value can be used as an identification marker between live and dead broiler meat, which is an ethical as well as religious issue.

Introduction

Broiler meat is one of the most nutritional foods in the human diet. It is an important source of animal-based protein (Akhter et al., 2022; Bithi et al., 2020; Boby et al., 2021; Rahman et al., 2023). In many countries, it has become a major consumer product (Elahi et al., 2020). Due to its valuable nutrients, it is a high-value item in the diet. In Bangladesh, the production of broiler meat and meat products increased consistently. Poultry meat continues to grow in popularity among consumers due to its affordability, availability, and nutritional qualities. In 2020, consumption of total poultry meat was at an all-time high of 113.5 pounds per capita, and approximately 45 billion pounds of chicken product was marketed on a ready-to-cook basis in the US (NCC, 2020). The poultry industry is very much a consumer-driven market with various segments to satisfy the needs of the customers. It indicates that broiler meat and meat products occupy a large proportion of people's food items. Since the use of broiler meat is an increasing trend, consumers are also careful about the differentiation between live and dead broilers. A large number of broilers have died due to transportation stress and heat stress. These dead broilers may be used as food and food products in various restaurants. Besides the time period, the quality deterioration of broiler meat is also a threatening issue. The same scenarios are prevailing in Bangladesh. Therefore, the quality attributes determination of broiler meat is essential (Islam et al., 2019).

With the continuous development of living standards and the relative change of dietary structure, consumers' rising and persistent demand for safe broiler meat and better quality meat is emphasized. The quality of broiler meat (e.g., color, pH, drip loss, cooking loss, WHC, sensory attributes, etc.) is technologically and economically important not only for the food-processing

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industry but also for consumers as an important attribute when purchasing meat (Disha et al., 2020; Hashem et al., 2021; Khatun et al., 2022; Sarker et al., 2021). To realize these needs mentioned above and to fulfill consumers' satisfaction, it is very important to provide meat that can better meet the customers' needs and market requirements. Therefore, it is a crucial element within the meat industry to assess meat and guarantee its quality and safety accurately. Different techniques, such as sensory analysis, chemical procedures, and instrumental methods, have been employed to provide information about meat quality (Brondum et al., 2000). In light of the foregoing, the present study was conducted to determine the sensory and physicochemical attributes of live and dead broiler meat.

Materials and Methods

Materials

Required equipment and preparation of instruments

The equipment required were a Plastic pot, Refrigerator, Crucible, HANNA meat pH meter, Digital food grade thermometer, Minolta colorimeter, Water bath, Petri dishes, knife, chopping board, water, and tissue paper. All necessary instruments were cleaned with hot water and detergent powder and then autoclaved and dried properly before starting the experimental activities.

Sample collection and preparation

Broiler samples were collected from a local commercial market known as Shomvugonj Bazar, Mymensingh, at 7:00 a.m. every morning for 4 successive days. Fifteen15 live birds and 5 dead birds were collected from this local market. Then, the live and dead bird samples were immediately transferred to the Animal Science Laboratory, Bangladesh Agricultural University, Mymensingh. After removing the carcass, deboning and cleaning was done. After deboning and cleaning, the breast, thigh, and liver parts were collected and prepared for analysis.

Methods

Sensory evaluation

Different sensory attributes were examined. Each sample was evaluated by a trained 6-member panel. The sensory questionnaires measured intensity on a 5-point balanced semantic scale (weak to strong) for the following attributes: color, flavor, tenderness, juiciness, and overall acceptability. The judges evaluated the samples based on the above criteria. Panelists were selected among department staff and students and trained according to the American Meat Science Association guidelines (AMSA, 1995). Sensory evaluation was carried out in individual booths under controlled conditions of light, temperature, and humidity. Prior to sample evaluation, all panelists participated in orientation sessions to familiarize themselves with the scale attributes (color, flavor, tenderness, juiciness, and overall acceptability) of broiler breast, thigh, and liver using an intensity scale. Sensory qualities of the samples were evaluated for live and dead broiler breast, thigh, and liver using a 5-point scoring method. Sensory scores were 5 for excellent, 4 for very good, 3 for good, 2 for fair, and 1 for poor (Rahman et al., 2012). All samples were served in the Petri dishes. Sensory evaluation was accomplished at 0 h of intervals and repeated at 24 h of intervals of refrigerated storage at 4 degrees Celsius.

Physicochemical properties

pH value estimation

The pH value in meat was measured by direct contact between the sensitive diaphragm of the electrode and meat tissue. Through the diaphragm, differences in electrical load between the meat and electrolyte solution (e.g., Potassium chloride, KCl) inside the glass electrode are measured and directly indicated as the pH-reading. In raw fresh meat, it is necessary to spray small amounts of distilled water onto the tissue at the point of measurement (prior to inserting the electrode) because the operation requires some fluidity in the sample, and the glass electrode should be thoroughly wet. The pH meter was calibrated before use and adjusted to the temperature of the tissue to be measured. The electrode was rinsed with distilled water after each measurement. pH value was estimated at 0 h and 24 h intervals of both live and dead broiler breast, liver, and thigh.

Determination of Cooking Loss

Cooking loss was measured using a hot water bath and food grade thermometer at 71˚C internal temperature of the meat sample. Cooking loss was determined at 0 h and 24 h of intervals. Cooking loss was estimated by using the following calculation:
Cooking loss= Wt. before cooking - Wt. after cooking/Wt. before cooking × 100.

Determination of Drip Loss

Samples were stored in a refrigerator at 4°C for 24 hrs to measure drip loss. Drip loss was calculated twice for both live and dead bird breast, thigh, and liver. For the first time, drip loss was calculated at 0 h, and for the second time, drip loss was calculated at 24 h intervals. Meat samples were suspended in tightly sealed plastic bags filled with air and kept at 4°C for 24 h (Honikel, 1998). Drip loss was calculated as a percentage of the weight loss after suspension.

Water Holding Capacity

WHC was measured according to Choi et al. (2018). Thawed samples (1 g each) were wrapped in absorbent cotton and placed in a centrifugal tube (Spinwin^{TM}, Tarsons, Kolkata, India). The tubes with samples were centrifuged in a centrifuge separator (1730R, Lynge, Denmark) at 3,000 × g for 10 min at 4°C, following which the samples were weighed. The WHC of the sample is expressed as the ratio of the sample weight after centrifugation to the initial sample weight using the following formula:

Water holding capacity (%) = Sample weight after centrifugation (g)/Sample weight before centrifugation (g) × 100

Color value estimation

Color values like lightness (CIE L*), redness (CIE a*), and yellowness (CIE b*) for meat samples were determined utilizing a colorimeter (Konica Minolta CR-410, Tokyo, Japan). The standard white plate (Y = 81.2; x = 0.3191; y = 0.3263) was employed for calibrating the colorimeter, and each sample was measured thrice. The measurement for hue angle (h°) and chroma (C*) value was carried out utilizing two equations of {tan−1(b*/a*)} and {(a^{*2} + b^{*2})1/2}, respectively.

Statistical model and analysis

Data were analyzed through 2 × 2 factorial experiments using SAS Statistical Discovery Software, NC, USA. DMRT test was used to determine the significance of differences among treatment means.

Results and Discussion

Sensory evaluation

Color

The subjective evaluation of the color score of live and dead broiler breast at 0 h and 24 h are shown in Table 1. The range of mean values of the overall observed color score at live and dead bird breasts was 3.80 and 1.70. The most preferable color was observed from live broiler breast meat ($p< 0.05$). The color at 0 h and 24 h was 3.40 and 2.10. The most preferable color was observed in fresh condition. The data showed that the color deteriorated significantly ($p< 0.05$) with the increased storage period for both treatments. A decrease in meat appearance and color scores with an increased storage period was also reported by Israt et al. (2018) and Singh et al. (2014).

The subjective evaluation of the color score of live and dead broiler thighs with h of intervals is shown in Table 2. The range of mean values of the overall observed color score at live and dead bird thigh was 4.90 and 1.80. The most preferable color was observed from live broiler thigh meat ($p< 0.05$). The color at 0 h and 24 h was 3.50 and 3.20. Most preferable color was observed from a fresh condition. The data showed that the color deteriorated insignificantly ($p> 0.05$) with the increase in the postmortem storage period for both treatments. Chidanandaiah and Sanyal (2009) also conducted an experiment, and meat color also decreased with the increasing storage period.

The subjective evaluation of color score of live and dead broiler liver with h of intervals are shown in Table 3. The range of mean value of overall observed color score at live and dead bird liver was 4.80 and 1.30. Most preferable color was observed from live broiler liver ($p<0.05$). The color at 0 h and 24 h was 3.30 2.80. Most preferable color was observed in fresh condition. The data showed that the color deteriorated significantly ($p<0.05$) with the increase in storage period for both treatments. A decrease in the appearance and color scores of meat with an increase in storage period was also reported by Kandeepan et al. (2010) and Kilinc (2009). The decreased color test scores during storage resulted from the denaturation of proteins, particularly the myofibrillar protein (actin and myosin) that affects gel formation Agnihotri et al. (2006) and Rahman et al. (2022).

Flavor

The subjective evaluation of flavor score of live and dead broiler breast with h of intervals are shown in Table 1. The range of mean value of overall observed flavor score at live and dead bird breast was 3.70 and 1.90. Most preferable flavor was observed from live broiler breast meat ($p< 0.05$). The flavor at 0 h and 24 h was 3.40 and 2.20. Most preferable flavor was observed in fresh condition. The data showed that the flavor was deteriorated significantly ($p< 0.05$) with the increase in storage period for both treatments. A similar result was reported by Israt et al. (2018).

The subjective evaluation of flavor score of live and dead broiler thigh with h of intervals are shown in Table 2. The range of mean value of overall observed flavor score at live and dead bird thigh was 4.80 and 1.70. Most preferable flavor was observed from live broiler thigh meat ($p< 0.05$). The flavor at 0 h and 24 h was 3.40 and 3.10. Most preferable flavor was observed at fresh condition. The data showed that the flavor deteriorated insignificantly ($p> 0.05$) with the increase in storage period for both treatments. A decrease in flavor scores of meat and meat products during storage was also reported by Zargar et al. (2014).

The subjective evaluation of the flavor score of live and dead broiler liver with h of intervals is shown in Table 3. The range of mean values of the overall observed flavor score at live and dead bird liver was 4.80 and 1.00. Most preferable flavor was observed from live broiler liver ($p< 0.05$). The flavor at 0 h and 24 h was 3.00 and 2.80. Most preferable flavor was observed in fresh condition. The data showed that the flavor deteriorated insignificantly ($p> 0.05$) with the increase in storage period for both treatments. Deterioration of flavor during storage might be due to microbial growth, formation of FFA, and oxidative rancidity (Devatkal et al. (2003). The progressive decrease in flavor could be correlated to an increase in TBARS values of meat products stored under aerobic conditions. The decline in flavor scores of meat products during storage was also reported by Malav et al. (2013) and Thomas et al. (2006) in different meat and meat products.

Tenderness

The subjective evaluation of tenderness score of live and dead broiler breasts with h of intervals is shown in Table 1. The range of mean value of overall observed tenderness score at live and dead bird breast was 4.00 and 1.80. Most preferable tenderness was observed from live broiler breast meat ($p< 0.05$). The tenderness at 0 h and 24 h was 3.50 and 2.30. Most preferable tenderness was observed in fresh condition. The data showed that the tenderness deteriorated significantly ($p< 0.05$) with the increase in storage period for both treatments. The subjective evaluation of tenderness score of live and dead broiler thigh with h of intervals are shown in Table 2. The range of mean value of overall observed tenderness score at live and dead bird thigh was 4.60 and 1.90. Most preferable tenderness was observed from live broiler thigh meat ($p< 0.05$). The tenderness at 0 h and 24 h was 3.30 and 3.20. Most preferable tenderness was observed in fresh condition. The data showed that the tenderness deteriorated insignificantly ($p> 0.05$) with the increase in storage period for both treatments. A similar result was also reported by Syuhairah et al. (2016).

The subjective evaluation of tenderness score of live and dead broiler liver with h of intervals are shown in Table 3. The range of mean value of overall observed tenderness score at live and dead bird liver was 4.80 and 1.50. Most preferable tenderness was observed from live broiler liver ($p< 0.05$). The tenderness at 0 h and 24 h was 3.40 and 2.90. Most preferable tenderness was observed in fresh condition. The data showed that the flavor was deteriorated significantly ($p< 0.05$) with the increase in storage period for both treatments. The result of this experiment is related to Ngapo et al. (2005) and Mcmillin's (2008) findings.

Juiciness

The subjective evaluation of the juiciness score of live and dead broiler breast with h of intervals is shown in Table 1. The range of mean value of overall observed tenderness score at live and dead bird breast was 3.80 and 1.70. Most preferable juiciness was observed from live broiler breast meat ($p< 0.05$). The juiciness at 0 h and 24 h was 3.50 and 2.30. Most preferable juiciness was observed at fresh condition. The data showed that the juiciness was deteriorated significantly ($p< 0.05$) with the increase of storage period for both treatments. The result of this experiment is supported by Lui et al. (2010) and Islam et al. (2022) findings.

The subjective evaluation of juiciness score of live and dead broiler thighs with h of intervals are shown in Table 2. The range of mean value of overall observed tenderness score at live and dead bird thigh was 4.30 and 1.70. Most preferable tenderness was observed from live broiler thigh meat ($p> 0.05$). The juiciness at 0 h and 24 h was 3.20 and 2.80. Most preferable juiciness was observed in fresh condition. The data showed that the juiciness deteriorated insignificantly ($p> 0.05$) with the increase in storage period for both treatments. The results were in accordance with the findings of Raja et al. (2014). The subjective evaluation of the juiciness score of live and dead broiler liver with h of intervals is shown in Table 3. The range of mean value of overall observed juiciness score at live and dead bird liver was 4.90 and 1.40. Most preferable juiciness was observed from live broiler liver ($p< 0.05$). The juiciness at 0 h and 24 h was 3.40 and 2.90. Most preferable juiciness was observed in fresh condition. The data showed that the juiciness deteriorated significantly ($p< 0.05$) with the increase in storage period for both treatments. Thomas et al. (2006) who also reported a decline in the juiciness scores of different meat products during storage.

Overall acceptability

The subjective evaluation of overall acceptability score of live and dead broiler breast with h of intervals are shown in Table 1.The range of mean value of overall acceptability score at live and dead bird breast was 4.00 and 1.80. Most preferable acceptability was observed from live broiler breast meat ($p< 0.05$). The overall acceptability at 0 h and 24 h was 3.50 and 2.30. The most preferable acceptability was observed at fresh conditions. The data showed that the overall acceptability deteriorated significantly ($p< 0.05$) with the increase of storage period for both treatments. This finding is related to Rahman et al. (2012).

The subjective evaluation of overall acceptability score of live and dead broiler thigh with h of intervals are shown in Table 2. The range of mean value of overall acceptability at live and dead bird thigh was 4.80 and 1.90. Most preferable acceptability was observed from live broiler thigh meat ($p< 0.05$). The overall acceptability at 0 h and 24 h was 3.50 and 3.20. Most preferable acceptability was observed at fresh conditions. The data showed that the overall acceptability was deteriorated insignificantly ($p> 0.05$) with the increase in storage period for both the treatments. Similar findings were confirmed by the results of Yadav et al. (2018).

The subjective evaluation of overall acceptability score of live and dead broiler liver with h of intervals are shown in Table 3. The range of mean value of overall acceptability at live and dead bird liver was 4.90 and 1.30. Most preferable acceptability was observed from live broiler liver ($p< 0.05$). The overall acceptability at 0 h and 24 h was 3.30 and 2.90. Most preferable flavor was observed at fresh condition. The data showed that the overall acceptability was deteriorated significantly ($p< 0.05$) with the increase in storage period for both treatments. Israt et al. (2018) reported that the overall acceptability decreased significantly during the storage period.

Table 1. Sensory evaluation of breast meat in live and dead broiler at 24 h of intervals

Parameters	H of intervals	Treatments			Level of significance		
		Live broiler	Dead broiler	Mean±SEM	Treatments	HI	T*HI
Color	0	4.80±0.20	2.00±0.00	3.40^{a}±0.10	<0.0001	<0.0001	0.002
	24	2.80±0.20	1.40±0.24	2.10^{b}±0.22			
	Mean±SEM	3.80^{a}±o.20	1.70^{b}±0.12				
Flavor	0	4.80±0.20	2.00±0.00	3.40^{a}±0.10	<0.0001	<0.0001	<0.0001
	24	2.60±0.24	1.80±0.20	2.20^{b}±0.22			
	Mean±SEM	3.70^{a}±0.22	1.90^{b}±0.10				
Tenderness	0	5.00±0.00	2.00±0.00	3.50^{a}±0.00	<0.0001	<0.0001	<0.0001
	24	3.00±0.00	1.60±0.24	2.30^{b}±0.12			
	Mean±SEM	4.00^{a}±0.00	1.80^{b}±0.12				
Juiciness	0	5.00±0.00	2.00±0.00	3.50^{a}±0.00	<0.0001	<0.0001	<0.0001
	24	2.60±0.24	1.40±0.24	2.00^{b}±0.24			
	Mean±SEM	3.80^{a}±0.00	1.70^{b}±0.12				
Overall acceptability	0	5.00±0.00	2.00±0.00	3.50^{a}±0.00	<0.0001	<0.0001	<0.0001
	24	3.00±0.00	1.60±0.24	2.30^{b}±0.12			
	Mean±SEM	4.00^{a}±0.00	1.80^{b}±0.12				

Sensory Scores were 5 for excellent, 4 for very good, 3 for good, 2 for fair, and 1 for poor. The mean in each row having different superscript varies significantly at values p<0.05, HI= h of intervals, T*HI= interaction of treatment and h of intervals.

Table 2. Sensory evaluation of thigh meat in live and dead broiler at 24 h of intervals

Parameters	H of intervals	Treatments			Level Of Significance		
		Live Broiler	Dead Broiler	Mean±SEM	Treatments	HI	T*HI
Color	0	5.00±0.00	2.00±0.00	3.50^{a}±0.00	<0.0001	0.076	0.536
	24	4.80±0.20	1.60±0.24	3.20^{a}±0.22			
	Mean±SEM	4.90^{a}±0.10	1.80^{b}±0.12				
Flavor	0	5.00±0.00	1.80±0.20	3.40^{a}±0.10	<0.0001	0.1531	0.624
	24	4.60±0.24	1.60±0.24	3.10^{a}±0.24			
	Mean±SEM	4.80^{a}±0.12	1.70^{b}±0.22				
Tenderness	0	4.60±0.24	2.00±0.00	3.30^{a}±0.12	<0.0001	0.6239	0.624
	24	4.60±0.24	1.80±0.20	3.20^{a}±0.22			
	Mean±SEM	4.60^{a}±0.18	1.90^{b}±0.10				
Juiciness	0	4.60±0.24	1.80±0.20	3.20a±0.22	<0.0001	0.0628	0.332
	24	4.00±0.00	1.60±0.24	2.80^{a}±0.12			
	Mean±SEM	4.30^{a}±0.21	1.70^{b}±0.22				
Overall accepatability	0	5.00±0.00	2.00±0.00	3.50^{a}±0.00	<0.0001	0.076	0.536
	24	4.60±0.24	1.80±0.20	3.20^{a}±0.22			
	Mean±SEM	4.80^{a}±0.12	1.90^{b}±0.10				

Sensory Scores were 5 for excellent, 4 for very good, 3 for good, 2 for fair, and 1 for poor. The mean in each row having different superscript varies significantly at values $p<0.05$, HI= h of intervals, T*HI= interaction of treatment and h of intervals.

Table 3. Sensory evaluation of liver in live and dead broiler at 24 h of intervals

Parameters	H of intervals	Treatments			Level of significance		
		Live Broiler	Dead Broiler	Mean±SEM	Treatments	HI	T*HI
Color	0	5.00±0.00	1.60±0.24	3.30^{a}±0.12	<0.0001	0.0107	0.572
	24	4.60±0.24	1.00±0.00	2.80^{b}±0.12			
	Mean±SEM	4.80^{a}±0.12	1.30^{b}±0.12				
Flavor	0	5.00±0.00	1.00±0.00	3.00^{a}±0.00	<0.0001	0.122	0.122
	24	4.60±0.24	1.00±0.00	2.80^{a}±0.12			
	Mean±SEM	4.80^{a}±0.12	1.00^{b}±0.00				
Tenderness	0	5.00±0.00	1.80±0.20	3.40^{a}±0.10	<0.0001	0.0167	0.6
	24	4.60±0.24	1.20±0.20	2.90^{b}±0.22			
	Mean±SEM	4.80^{a}±0.12	1.50^{b}±0.20				
Juiciness	0	5.00±0.00	1.80±0.20	3.40^{a}±0.10	<0.0001	0.0027	0.05
	24	4.80±0.20	1.00±0.00	2.90^{b}±0.10			
	Mean±SEM	4.90^{a}±0.10	1.40^{b}±0.10				
Overall acceptability	0	5.00±0.00	1.60±0.24	3.30a±0.12	<0.0001	0.0223	0.224
	24	4.80±0.20	1.00±0.00	2.90^{b}±0.10			
	Mean±SEM	4.90^{a}±0.10	1.30^{b}±0.12				

Sensory Scores were 5 for excellent, 4 for very good, 3 for good, 2 for fair, and 1 for poor. The mean in each row having different superscript varies significantly at values $p<0.05$, HI= h of intervals, T*HI= interaction of treatment, and h of intervals.

Physicochemical properties evaluation

The subjective evaluation of the pH score of live and dead broiler breast with h of intervals is shown in Table 4. The range of mean value of overall observed pH score at live and dead bird breast was 6.50 and 6.39. The pH at 0 h and 24 h was 6.52 and 6.37. Most preferable juiciness was observed in fresh condition. The data showed that the pH deteriorated significantly ($p< 0.05$) with the increase in storage period for both treatments. Similar findings were also reported by Biswas et al. (2004).

Table 4. Physicochemical attributes of breast meat in live and dead broiler at 24 h of intervals

Physicochemical attributes	H of Intervals	Treatments			Level of Significance		
		Live broiler	Dead broiler	Mean±SEM	Treatments	HI	T*HI
	0	6.65±0.11	6.38±0.05	6.52^{a}±0.08	0.136	0.0483	0.029
	24	6.35±0.03	6.40±0.02	6.37^{b}±0.02			
pH	Mean±SEM	6.50^{a}±0.07	6.39^{a}±0.03				
Cooking loss	0	18.53±1.48	19.45±0.78	18.99^{a}±1.13	0.3233	0.057	0.891
	24	20.53±1.11	21.75±0.59	21.14^{a}±0.85			
	Mean±SEM	19.53^{a}±1.29	20.60^{a}±0.68				
Drip Loss	0	4.75±0.53	4.08±0.19	4.41^{b}±0.36	0.3773	0.0026	0.41
	24	5.79±0.45	5.76±0.24	5.78^{a}±0.34			
	Mean±SEM	5.27^{a}±0.49	4.92^{a}±0.21				
WHC	0	97.72±0.12	97.69±0.21	97.70^{a}±0.16	0.044	<0.0001	0.055
	24	94.27±0.35	93.02±0.40	93.64^{b}±0.37			
	Mean±SEM	96.00^{a}±0.23	95.35^{b}±0.30				
L*	0	48.55±1.30	40.67±0.23	44.61a±0.76	<0.0001	0.1441	0.029
	24	53.45±1.71	39.60±1.23	46.52^{a}±1.47			
	Mean±SEM	51.00^{a}±1.50	40.13^{b}±0.73				
a*	0	3.73±0.35	16.69±1.66	10.21^{a}±1.00	<0.0001	0.9567	0.254
	24	4.92±0.39	15.61±0.79	10.26^{a}±0.59			
	Mean±SEM	4.32^{b}±0.37	16.15^{a}±1.24				
b*	0	5.77±0.39	7.49±0.65	6.63^{a}±0.52	0.9526	0.8243	0.117
	24	7.79±1.60	5.95±1.21	6.87^{a}±1.40			
	Mean±SEM	6.78^{a}±0.99	6.72^{a}±0.93				
Chroma	0	6.87±0.37	18.29±1.16	12.58^{a}±0.77	<0.01	<0.45	<0.003
	24	9.21±0.38	16.70±1.00	12.96^{a}±0.99			
	Mean±SEM	8.04^{b}±0.68	17.45^{a}±1.09				
Hue Angle	0	57.12±0.37	24.17±1.16	40.65^{a}±0.76	<0.0001	<0.019	<0.0031
	24	57.72±0.38	20.86±1.00	39.29^{b}±0.99			
	Mean±SEM	57.42^{a}±0.68	22.59^{b}±1.09				

The subjective evaluation of the pH score of live and dead broiler thigh with h of intervals are shown in Table 5. The range of mean value of pH at live and dead bird thigh was 6.38 and 6.55. Most preferable pH was observed from live broiler thigh meat ($p < 0.05$). The pH at 0 h and 24 h was 6.48 and 6.44. Most preferable acceptability was observed at fresh conditions. The data showed that the pH deteriorated insignificantly ($p > 0.05$) with the increase in storage period for both treatments. Mccarthy et al. (2001) and Das et al. (2022) also reported a similar report.

Table 5. Physicochemical attributes of thigh meat in live and dead Broiler at 24 h of intervals

Physicochemical Attributes	**H of intervals**	**Treatments**			**Level of Significance**		
		Live broiler	**Dead broiler**	**Mean±SEM**	**Treatments**	**HI**	**T*HI**
pH	0	6.44±0.08	6.52±0.02	6.48^{a} ± 0.05	0.005	0.5107	0.093
	24	6.31±0.04	6.58±0.02	6.44^{a} ± 0.03			
	Mean±SEM	6.38^{b}±0.06	6.55^{a}±0.02				
Cooking Loss	0	22.57±1.04	22.10±0.30	22.33^{a}±0.67	0.7623	0.0559	0.744
	24	23.84±0.97	23.86±0.17	23.85^{a}±0.57			
	Mean±SEM	23.21^{a}±0.55	22.98^{a}±0.23				
Drip Loss	0	5.46±0.95	4.05±0.71	4.75^{a}±0.83	0.1702	0.136	0.731
	24	6.43±0.82	5.57±0.65	6.00^{a}±0.73			
	Mean±SEM	5.95^{a}±0.88	4.81^{a}±0.68				
WHC	0	96.86±0.19	95.78±0.48	96.32^{a}±0.33	0.0073	<0.0001	0.485
	24	93.72±0.27	91.99±0.70	92.86^{b}±0.48			
	Mean±SEM	95.29^{a}±0.23	93.88^{b}±0.59				
L*	0	57.12±1.02	46.82±1.49	51.97^{a}±1.25	<0.0001	0.4912	0.739
	24	55.64±1.63	46.30±1.45	50.97^{a}±1.54			
	Mean±SEM	56.38^{a}±1.32	46.56^{b}±1.47				
a*	0	6.90±0.71	11.97±1.19	9.44^{b}±0.95	<0.0001	0.0176	0.75
	24	8.84±0.60	14.45±0.69	11.65^{a}±0.64			
	Mean±SEM	7.87^{b}±0.65	13.21^{a}±0.94				
b*	0	8.99±0.75	7.60±1.06	8.29^{a}±0.90	0.0035	0.0479	0.156
	24	8.52±0.27	5.00±0.52	6.76^{b}±0.39			
	Mean±SEM	8.75^{a}±0.51	6.30^{b}±0.79				
Chroma	0	11.33±0.73	14.17±1.13	12.75^{b}±0.93	0.0002	0.04	0.84
	24	12.27+0.44	15.29±0.61	13.78^{a}±0.52			
	Mean±SEM	11.8^{b}±0.58	14.73^{a}±0.67				
Hue angle	0	52.49±0.73	32.41±1.13	42.45^{a}±0.93	<0.001	<0.001	<0.001
	24	43.94±0.44	19.08±0.61	31.51^{b}±0.52			
	Mean±SEM	48.22^{a}±0.58	25.75^{b}±0.67				

The subjective evaluation of the pH score of live and dead broiler liver with h of intervals is shown in Table 6. The range of mean values of pH at live and dead bird liver was 6.44 and 6.59. Most preferable pH was observed from live broiler liver meat ($p < 0.05$). The pH at 0 h and 24 h was 6.54 and 6.50 and it was observed in fresh condition. The data showed that the pH deteriorated insignificantly (p> 0.05) with the increase of storage period for both treatments. Same report was reported by McCarthy et al. (2001).

Table 6. Physicochemical attributes of liver in live and dead broiler at 24 h of intervals

Physicochemical attributes	H of intervals	Treatments			Level of significance		
		Live broiler	Dead broiler	Mean±SEM	Treatments	HI	T*HI
pH	0	6.48±0.03	6.59±0.05	6.54^{a}±0.04	0.0024	0.3841	0.384
	24	6.41±0.01	6.59±0.05	6.50^{a}±0.03			
	Mean±SEM	6.44^{b}±0.02	6.59^{a}±0.05				
Cooking loss	0	19.15±0.76	23.54±1.56	21.35^{b}±0.73	0.0029	0.0066	0.859
	24	23.08±0.71	27.05±1.46	25.06^{a}±1.08			
	Mean±SEM	21.12^{b}±0.73	25.29^{a}±1.51				
Drip loss	0	9.89±0.39	10.86±0.66	10.38^{b}±0.52	0.1446	0.0016	0.901
	24	12.18±0.65	13.01±0.58	12.60^{a}±0.61			
	Mean±SEM	11.04^{a}±0.52	11.94^{a}±0.62				
WHC	0	94.89±0.36	95.89±0.26	95.39^{a}±0.31	0.5268	<0.0001	0.078
	24	90.71±0.25	90.22±0.59	90.46^{b}±0.42			
	Mean±SEM	92.80^{a}±0.30	93.06^{a}±0.42				
L*	0	44.03±1.59	33.93±0.30	38.98^{a}±0.94	<0.0001	0.7216	0.317
	24	43.36±0.91	35.32±0.70	39.34^{a}±0.80			
	Mean±SEM	43.69^{a}±1.25	34.63^{b}±0.50				
a*	0	19.12±0.52	21.86±0.66	20.49^{a}±0.59	0.4373	<0.0001	1E-04
	24	18.20±0.45	14.44±0.83	16.32^{b}±0.64			
	Mean±SEM	18.66^{a}±0.48	18.15^{a}±0.74				
b*	0	11.73±1.04	8.40±0.26	10.06^{a}±0.65	0.0002	0.3076	0.936
	24	11.04±0.75	7.60±0.49	9.32^{a}±0.62			
	Mean±SEM	11.38^{a}±0.89	8.00^{b}±0.37				
Chroma	0	22.43±0.78	23.42±0.46	22.93^{a}±0.62	<0.0006	<0.001	<0.0001
	24	21.28±0.60	16.32±0.66	18.8^{b}±0.63			
	Mean±SEM	21.86^{a}±0.69	19.87^{b}±0.56				
Hue angle	0	31.53±0.78	21.01±0.46	26.27^{b}±0.62	<0.006	<0.001	<0.001
	24	31.24±0.60	27.76±0.66	29.5^{a}±0.63			
	Mean±SEM	31.38^{a}±0.69	24.39^{b}±0.56				

Cooking Loss

The subjective evaluation of the cooking loss score of live and dead broiler breasts with h of intervals is shown in Table 4. The range of mean value of overall observed cooking loss score at live and dead bird breast was 19.53 and 20.63. The cooking loss at 0 h and 24 h was 18.99 and 21.14 and it was observed in fresh conditions. The data showed that the cooking loss was deteriorated insignificantly (p> 0.05) with the increase of storage period for both treatments. This experimental finding is related to Jama et al. (2008) and Farzana et al. (2017).

The subjective evaluation of the cooking loss score of live and dead broiler thigh with h of intervals are shown in Table 5. The range of mean value of the overall observed cooking loss score at 0 h and 24 h was 23.21 and 22.98. The cooking loss at two h of intervals was 22.33 and 23.88 and it was observed in fresh condition. The data showed that the cooking loss deteriorated insignificantly (p> 0.05) with the increase in storage period for both treatments.

The subjective evaluation of cooking loss score of live and dead broiler liver with h of intervals are shown in Table 6. The range of mean value of overall observed cooking loss score at live and dead bird liver was 21.12 and 25.29. Most preferable cooking loss was observed from dead broiler liver meat (p< 0.05). The cooking loss at 0 h and 24 h was 21.35 and 25.06. Most preferable cooking loss was observed at fresh condition. The data showed that the cooking loss deteriorated significantly (p< 0.05) with the increase in storage period for both treatments. This experiment is supported by Yu et al. (2005).

Drip Loss

The subjective evaluation of drip loss of live and dead broiler breast with h of intervals is shown in Table 4. The range of mean value of overall observed drip loss score at live and dead bird breast was 11.04 and 11.94. Most preferable drip loss was observed from live broiler breast meat (p> 0.05). The drip loss at 0 h and 24 h was 10.38 and 12.60. Most preferable drip loss was observed in fresh conditions. The data showed that the drip loss deteriorated significantly (p< 0.05) with the increase in storage period for both treatments.

The subjective evaluation of drip loss score of live and dead broiler thigh with h of intervals are shown in Table 5. The range of mean value of overall observed drip loss score at live and dead bird thigh was 5.95 and 4.81. The drip loss at 0 h and 24 h was 4.75 and 6.00. The most preferable drip loss was observed in fresh conditions. The data showed that the drip loss deteriorated significantly (p< 0.05) with the increase in storage period for both treatments.

The subjective evaluation of drip loss score of live and dead broiler liver with h of intervals are shown in Table 6. The range of mean value of overall observed drip loss score at live and dead bird liver was 11.04 and 11.94. Most preferable drip loss was observed from live broiler liver meat (p> 0.05). The drip loss at 0 h and 24 h was 10.38 and 12.60. Most preferable drip loss was observed in fresh condition. The data showed that the drip loss deteriorated significantly (p< 0.05) with the increase of storage period for both treatments.

Water Holding Capacity

The subjective evaluations of water holding capacity of live and dead broiler breast with h of intervals are shown in Table 4. The range of mean value of overall observed WHC% at live and dead bird breast was 96.00 and 95.35. Most preferable WHC was observed from live broiler breast meat ($p<0.05$). The WHC at 0 h and 24 h was 97.70 and 93.64. Most preferable WHC was observed at fresh condition. The data showed that the drip loss was deteriorated significantly ($p< 0.05$) with the increase in storage period for both treatments.

The subjective evaluation of the water Holding Capacity score of live and dead broiler thigh with h of intervals are shown in Table 5. The range of mean value of overall observed WHC% at live and dead bird thigh was 95.29 and 93.88. Most preferable WHC was observed from live broiler thigh meat ($p< 0.05$). The WHC at 0 h and 24 h was 96.32% and 92.86%. Most preferable WHC was observed at fresh condition. The data showed that the WHC decreased significantly ($p< 0.05$) with the increase of storage period for both treatments.

The subjective evaluations of the water holding capacity of live and dead broiler liver with h of intervals are shown in Table 6. The range of mean value of overall observed WHC% at live and dead bird liver was 92.80 and 93.06. The WHC% at 0 h and 24 h was 95.39 and 90.46. Most preferable WHC was observed at fresh condition. The data showed that the WHC deteriorated significantly ($p< 0.05$) with the increase in storage period for both treatments. These results agree with those reported previously (Barbut, 1997; Wilkins et al., 2000; Qiao et al., 2001).

Instrumental color values

The subjective evaluation of L* (lightness) of live and dead broiler breasts with h of intervals are shown in Table 4. The range of mean value of overall observed L* value at live and dead bird breast was 51.00 and 40.13. Most preferable L* value was observed from live broiler breast meat ($p< 0.05$). The L* value at 0 h and 24 h was 44.61 and 46.62. Preferable L* value was observed at 24 hs of storage. The data showed that the L* value deteriorated insignificantly ($p> 0.05$) with the increase in storage period for both treatments. This result is supported by Fletcher (1999). The subjective evaluation of L* (lightness) of live and dead broiler thigh with h of intervals is shown in Table 5. The range of mean value of overall observed L* value at live and dead bird thigh was 56.38 and 46.56. Most preferable L* value was observed from live broiler thigh meat ($p< 0.05$). The L* value at 0 h and 24 h was 51.97 and 50.97. Most preferable L* value was observed at fresh condition. The data showed that the L* value deteriorated insignificantly ($p> 0.05$) with the increase in storage period for both treatments. This result is similar to the result of Petracci et al. (2004).

The subjective evaluation of L* (lightness) of live and dead broiler liver with h of intervals is shown in Table 6. The range of mean value of overall observed L* value at live and dead bird liver was 43.69 and 34.63. Most preferable L* value was observed from live broiler liver meat ($p< 0.05$). The L* value at 0 h and 24 h was 38.98 and 39.34. Most preferable L* value was observed at 24 hrs of storage. The data showed that the L* value was decreased insignificantly ($p> 0.05$) with the increase of storage period for both treatments. The L* values can vary according to the broiler strain, slaughter age, post-slaughter holding temperature, and broiler processing plant (Woelfel et al., 2002). The subjective evaluation of a* (redness) of live and dead broiler breasts with h of intervals are shown in Table 4. The range of mean value of overall observed a* value at live and dead bird breast was 4.32 and 16.12. Most preferable a* value was observed from live broiler breast meat ($p< 0.05$). The a* value at 0 h and 24 h was 10.21 and 10.26. Most preferable a* value was observed at fresh condition. The data showed that a*value deteriorated insignificantly ($p> 0.05$) with the increase of storage period for both treatments. Due to myoglobin difference, redness may vary, which is reported by Froning et al. (1968).

The subjective evaluation of a* (redness) of live and dead broiler thigh with h of intervals is shown in Table 5. The range of mean value of overall observed a* value at live and dead bird thigh was 7.87 and 13.21. The most preferable a* value was observed from live broiler thigh meat ($p< 0.05$). The a* value at 0 h and 24 h was 9.44 and 11.65. Most preferable a* value was observed at fresh condition. The data showed that the a* value deteriorated significantly ($p< 0.05$) with the increase of storage period for both treatments. The same report was submitted by Ngoka et al. (1982). The subjective evaluation of a* (redness) of live and dead broiler liver with h of intervals are shown in Table 6. The range of mean value of overall observed a* value at live and dead bird liver was 18.66 and 18.15. The a* value at 0 h and 24 h was 20.49 and 16.32. Most preferable a* value was observed at 24 hs of storage. The data showed that the a* value was decreased significantly ($p< 0.05$) with the increase of storage period for both treatments. This is supported by Froning et al. (1978)

The subjective evaluation of b* (yellowness) of live and dead broiler breasts with h of intervals are shown in Table 4. The range of mean value of overall observed b* value at live and dead bird breast was 6.78 and 6.72. The b* value at 0 h and 24h was 6.63 and 6.87. Most preferable b* value was observed at fresh condition. The data showed that the b* value was decreased insignificantly ($p> 0.05$) with the increase of storage period for both treatments. The subjective evaluation of b* (yellowness) of live and dead broiler thigh with h of intervals is shown in Table 5. The range of mean value of overall observed b* value at live and dead bird thigh was 8.75 and 6.30. Most preferable b* value was observed from live broiler thigh meat ($p< 0.05$). The b* value at 0 h and 24 h was 8.29 and 6.76. Most preferable b* value was observed at fresh condition. The data showed that the b* value was decreased significantly ($p< 0.05$) with the increase of storage period for both treatments.

The subjective evaluation of b* (yellowness) of live and dead broiler liver with h of intervals are shown in Table 6. The range of mean value of overall observed b* value at live and dead bird liver was 11.38 and 8.00. The most preferable b* value was observed from live broiler liver ($p< 0.05$). The b* value at 0 h and 24 h was 10.06 and 9.32. Most preferable b* value was observed at fresh condition. The data showed that the b* value was decreased insignificantly ($p> 0.05$) with the increase of storage period for both treatments. Factors like freezing condition, sex, age, and processing procedure can affect the b* value of the liver was reported by Mugler and Cunningham (1972)

The subjective evaluation of SI (Saturation Index)/chroma value of live and dead broiler breast with h of intervals are shown in Table 4. The range of mean value of overall observed SI value at live and dead bird breast was 8.04 and 17.45. Most preferable SI value was observed from live broiler breast meat ($p < 0.05$). The SI values at 0 h and 24 h were 12.58 and 12.96. A preferable SI value was observed at fresh conditions. The data showed that the SI value decreased insignificantly ($p > 0.05$) with the increase in storage period for both treatments.

The subjective evaluation of SI (Saturation Index) of live and dead broiler thigh with h of intervals are shown in Table 5. The range of mean value of overall observed SI value at live and dead bird thigh was 11.80 and 14.73. Most preferable SI value was observed from live broiler thigh meat ($p < 0.05$). The SI values at 0 h and 24 h were 12.75 and 13.78. Most preferable SI value was observed at fresh condition. The data showed that the SI value decreased significantly ($p < 0.05$) with the increase in storage period for both treatments.

The subjective evaluation of the hue angle of live and dead broiler liver with h of intervals is shown in Table 6. The range of mean value of overall observed hue angle value at live and dead bird liver was 21.86 and 19.87. Most preferable hue angle value was observed from live broiler liver meat ($p < 0.05$). The hue angle value at 0 h and 24 h was 22.93 and 18.80. Most preferable hue angle value was observed at 24 hrs of storage. The data showed that the hue angle value was decreased significantly ($p < 0.05$) with the increase of storage period for both treatments.

The subjective evaluation of the hue angle of live and dead broiler breast with h° of intervals is shown in Table 4. The range of mean value of overall observed hue angle value at live and dead bird breast was 57.42 and 22.59. Most preferable hue angle value was observed from live broiler breast meat ($p < 0.05$). The hue angle value at 0 h and 24 h was 40.65 and 39.29. Preferable hue angle value was observed at fresh conditions. The data showed that the hue angle value was decreased significantly ($p < 0.05$) with the increase of storage period for both treatments.

The subjective evaluation of the Hue angle of live and dead broiler thigh with h of intervals are shown in Table 5. The range of mean value of overall observed hue angle value at live and dead bird thigh was 48.22 and 25.75. Most preferable hue angle value was observed from live broiler thigh meat ($p < 0.05$). The hue angle value at 0 h and 24 h was 42.45 and 31.51. Most preferable hue angle value was observed at fresh conditions. The data showed that the hue angle value was decreased significantly ($p < 0.05$) with the increase of storage period for both treatments.

The subjective evaluation of the hue angle of live and dead broiler liver with h of intervals is shown in Table 6. The range of mean value of overall observed hue value at live and dead bird liver was 31.38 and 24.39. Most preferable hue angle value was observed from live broiler liver ($p < 0.05$). The hue angle value at 0 h and 24 h was 26.27 and 29.50. Most preferable hue angle value was observed at 24 hrs of storage. The data showed that the hue value decreased significantly ($p < 0.05$) with the increase in storage period for both treatments.

Conclusions

The study was conducted to find out the sensory (color, flavor, tenderness, juiciness, overall acceptability) attributes and physicochemical attributes (pH, cooking loss, drip loss, water holding capacity, L*, a*, b*) of live and dead broiler at 0 h and 24 h of intervals. In conclusion, sensory attributes were significantly higher in live broiler meat than in dead birds meats. WHC, L*, a*, b*, SI, and chroma values are significantly higher in live broiler meat than in dead which can be used as an identification marker to differentiate between live and dead broiler meats.

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