Sri Lankan Journal of Technology
Research

SLJoT
2026 Sp. Issue (1) 56-63
ISSN-2773-6970

Physicochemical and Sensory Responses of Cobb 500 Broiler Meat to Varying Pre-Slaughter Holding Periods

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Received: 31-12-2025 * Accepted: 10-01-2026 * Published Online: 31-01-2026

Abstract– This study investigated the impact of three holding durations 1 hour, 2 hours, and 3 hours on the physicochemical, textural, and sensory properties of Cobb 500 broiler meat, using birds of uniform age and rearing conditions. Quality parameters assessed pH, moisture content, cooking loss, drip loss, crude protein, ash content, and colour values (L*, a*, b*), alongside textural attributes; adhesiveness, chewiness, springiness, gumminess, and cohesiveness. Statistical analyses were conducted at a significance level of $p < 0.05$. The results demonstrated that 3 hours holding period enhanced moisture content and meat brightness while reducing drip loss, though it also increased chewiness and gumminess. In contrast, 2 hours holding period stated higher protein retention, reduced cooking loss, and acceptable tenderness. 1 hour holding group consistently exhibited the least favourable outcomes across measured attributes. Sensory evaluation, analysed using the Friedman test ($p < 0.05$), confirmed that the 2 hours treatment achieved the highest scores for tenderness, flavour, texture, and overall acceptability. Colour and juiciness did not differ significantly among treatments; 2 hours group consistently outperformed the others. Findings indicate that a 2 hours pre-slaughter holding period represents the optimal strategy for improving both physicochemical and sensory quality of Cobb 500 broiler meat.

Keywords- Broiler chicken, Cobb 500, Holding duration, Meat quality, Pre-slaughter handling

Recommended APA Citation

Tennakoon, K.R.S., Kamil, K.M., Nikzaad, R.M., & Muneeb M. Musthafa (2026). The relationship between pre-slaughter holding time and meat quality in Cobb 500 broiler chickens. *Sri Lankan Journal of Technology, 7*(Special Issue 1), 56-63.

Introduction

The poultry industry is recognized as a significant part of the global agricultural sector, with the nutritional needs of millions of people being met by providing an essential source of protein. Over the past 3 decades, spectacular progress has been made in the poultry industry in many Asian countries, with it being rapidly transformed from a backyard industry into a dynamic and modern sector within agriculture. Although a cereal staple diet has long been maintained in Asian countries, recent economic growth and increased awareness have gradually changed dietary plans by including more meat (Manjula et al., 2018).

Among different poultry breeds used in this meat production process, the Cobb 500 broiler breed is regarded as a leading choice in commercial chicken production due to its rapid growth rate, feed efficiency, and desirable meat quality traits (Gholami et al., 2020). When slaughtering these broiler chickens for meat production, one of the most critical aspects of pre-slaughter handling is considered to be the holding period or the time birds are kept in holding areas without any food or water prior to slaughter. It is essential for stress in birds to be controlled and minimized after transportation, as the quality characteristics and sensory characteristics of meat can be affected by this stress after slaughter (Mir et al., 2017).

Pre-slaughter holding time is among the major factors that influence poultry meat quality due to its impact on stress levels, glycogen depletion, and muscle metabolism. Elevated oxidative stress due to longer holding times before slaughtering has been found to result in variation of ultimate pH, color, and water-holding capacity (Qiao et al., 2001). Short holding times have been shown to minimize the negative impacts of stress and improve meat quality, while longer holding times lead to dehydration, high drip loss, and worse meat texture with lower consumer preference (Fletcher, 2002). Such impacts of holding time on the meat quality traits necessitate a comparison study to determine the most suitable holding time to realize desirable Cobb 500 broiler meat traits.

Pre-slaughter handling, including transport and holding time, has been shown to have a direct impact on poultry meat texture and color, which are key drivers of consumer acceptance and preference (Tamzil et al., 2019). Holding time influences postmortem glycolysis, which impacts meat color, pH, and tenderness (Northcutt, 2001). Specifically, increased holding times have been linked to increased redness and decreased lightness, which can influence marketability and consumer acceptance as well (Bianchi et al., 2006). Pre-slaughter stressors, including increased lairage, have also been shown to be accountable for increased breast muscle toughness and decreased water-holding capacity, influencing fresh and processed meat quality (Petracci et al., 2004).

Given the economic significance of poultry meat and the preference and needs of consumers to acquire quality products, pre-slaughter condition improvements are required (Wilkins et al., 2000). Holding times need to be compared within controlled conditions and comprehension of their effects on the quality of the meat and sensory attributes of Cobb 500 broiler chickens is beneficial for the industry.

Materials and Methods

Study Location

Sampling and slaughter operations were performed at Bairaha Processing Plant, Pasyala, Sri Lanka. The laboratory analysis was carried out in the Department of Biosystems Technology, Faculty of Technology, South Eastern University of Sri Lanka.

Sample Collection

45 Cobb 500 broiler chickens, approximately 32 days old and weighing 2 kg on average, were used in this study. The chickens were reared in similar environmental and dietary

conditions. The birds were then randomly distributed into three treatment groups relating to 1 hour, 2 hours, and 3 hours pre-slaughter holding times. The birds were slaughtered humanely following the allocated holding durations, then samples of breast meat were collected to be analyzed subsequently.

Experimental Design

The experiment was conducted in three different treatment levels based on 1 hour, 2 hours, and 3 hours of pre-slaughter holding time. There were 15 birds in each of the treatment levels, and uniform handling as well as environmental controls were imposed on all subjects to avoid experimental variability. The main objective of the study was to determine whether holding time before slaughter has any impact on meat quality factors that include proximate composition, physical qualities, and sensory evaluation.

Proximate Analysis

The breast meat samples were analyzed for ash, moisture, and crude protein content to determine their nutritional quality. The content of moisture was determined using oven drying at 105 °C for 24 hours (AOAC, 2000). Ash content was determined by burning the samples in a muffle furnace at 550 °C for 4 hours, while the content of crude protein was determined by using the Kjeldahl technique, using a nitrogen-protein conversion factor of 6.25.

Physical Parameter Analysis

- pH: pH values were measured using a digital pH meter (Metrohm 827, Switzerland) in breast samples following methods set by Fletcher et al. (2000).
- Drip Loss: Drip loss measurement was carried out by storing the meat samples in closed containers at 4°C for 3 days. Weight percentage loss was calculated, which was used as an indicator of water holding capacity (Gholami et al., 2020).
- Cooking loss: Cooking loss was measured by weighing meat samples before and after immersion in a water bath that was set at a temperature of 85 °C for 10 minutes. The test acts as a measure of moisture retained during cooking (Barbut, 1997).
- Color: The meat color was measured using a colorimeter, which quantified lightness (L), redness (a), and yellowness (b). Three measurements were made in each of the samples in order to determine its aesthetic properties (Qiao et al., 2002).

Texture Profile Analysis

A Brookfield CT3 texture analyzer was used to conduct texture profile analysis to determine different parameters such as adhesiveness, chewiness, gumminess, cohesiveness, and springiness (Masoumi et al., 2018).

Sensory Evaluation

A hedonic scale of nine points was used to assess sensory attributes of the boiled meat samples, covering properties like color, tenderness, juiciness, taste, and overall acceptability, respectively. 30 untrained panellists quantitatively assessed these sensory properties in terms of sensory appearance, flavor, texture, and general perception, respectively. Each sample was scored from 1, reflecting extreme dislike, to 9, reflecting extreme like, using methods derived from Fletcher et al. (2000) and Barbut (1997).

Statistical Analysis

Data analysis used One-Way ANOVA to determine variances between means in different groups ($p \leq 0.05$). Sensory evaluation data were analyzed using the Friedman test, while all analytical tests were performed using SPSS version 27.0.

Results

Proximate Analysis

The proximate analysis performed among three different pre-slaughter holding times on moisture content, ash and crude protein attributes (Table 1). The 1hour group recorded the highest moisture content at 76.99 ± 0.61%, followed by the 2 hours group at 76.70 ± 0.54%, then the 3 hours group at 75.96 ± 0.32% ($p = 0.001$). In terms of ash content, 3 hours group recorded highest level at 1.21 ± 0.26%, while 1 hour group was 1.05 ± 0.09%, 2 hours group was 1.10 ± 0.06% ($p = 0.037$). The 1hour group recorded the highest level of crude protein at 22.99 ± 0.55%, followed by 3 hours group at 22.67 ± 0.64%, then the 2 hours group at 22.33 ± 0.63% ($p = 0.018$).

Table 1

Proximate analysis of meat

Attribute	1 Hour	2 Hours	3 Hours	p value
Moisture Content	76.99 ± 0.61^{a}	76.70 ± 0.54^{a}	75.96 ± 0.32^{b}	0.001
Ash Content	1.05 ± 0.09^{b}	1.10 ± 0.06^{ab}	1.21 ± 0.26^{a}	0.037
Crude Protein	22.99 ± 0.55^{a}	22.33 ± 0.63^{b}	22.67 ± 0.64^{ab}	0.018

Note. Values are expressed as mean ± standard deviation. Means within the same row followed by different superscript letters differ significantly at $p < 0.05$.

Physical Properties

pH readings had no statistically significant differences ($p = 0.166$) between holding time levels of 1 hour (5.45 ± 0.14), 2 hours (5.51 ± 0.16), and 3 hours (5.55 ± 0.13) (Table 2). Drip loss showed a slight increase with longer holding times; however, no significant differences were observed ($p = 0.080$). The 1 hour holding time group had the lowest drip loss (1.30 ± 0.91%), while the 2 hours group had a slightly higher value (1.17 ± 1.13%), and the 3 hours group had the greatest drip loss (1.98 ± 1.05%). The cooking loss among the 1hour group was significantly higher (15.71 ± 3.02%) when compared to that of the 3 hours group (13.78 ± 1.28%) ($p = 0.025$).

Table 2

Physical parameters analysis of meat

Attribute	1 Hour	2 Hours	3 Hours	p value
pH	5.45 ± 0.14^{a}	5.51 ± 0.16^{a}	5.55 ± 0.13^{a}	0.166
Drip loss	1.30 ± 0.91^{a}	1.17 ± 1.13^{a}	1.98 ± 1.05^{a}	0.080
Cooking Loss	15.71 ± 3.02^{a}	14.30 ± 0.56^{ab}	13.78 ± 1.28^{b}	0.025
Color (L)	41.49 ± 4.82^{a}	38.78 ± 3.26^{ab}	36.97 ± 3.74^{b}	0.013
Color (a)	3.01 ± 0.48^{a}	3.01 ± 1.09^{a}	3.24 ± 0.91^{a}	0.710
Color (b)	10.36 ± 1.42^{a}	10.88 ± 1.38^{a}	9.61 ± 1.88^{a}	0.099

Note. Values are expressed as mean ± standard deviation. Means within the same row followed by different superscript letters differ significantly at $p < 0.05$.

There is a significant difference in lightness (L), where the 1hour group had the highest lightness (41.49 ± 4.82), followed by the 2 hours group (38.78 ± 3.26), and the 3 hours group (36.97 ± 3.74) (p = 0.013) (Figure 1).

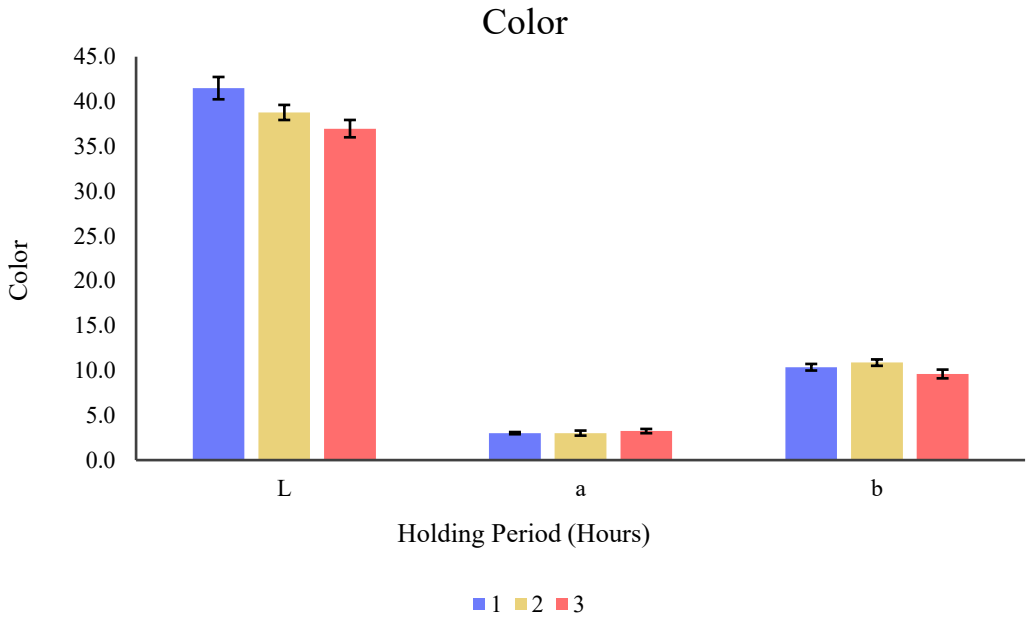

Figure 1. *Meat color values*

Textural Parameters

The texture properties of broiler breast meat were significantly impacted by pre-slaughter holding durations (Table 3). The group held for a 1 hour holding time recorded highest scores of chewiness, gumminess, and cohesiveness, meaning that meat was harder as a result of retaining more intact muscle fibers. The group held for 2 hours holding time recorded high springiness and tenderness levels, meaning that optimal holding times would enhance both tenderness and elasticity of meat by inducing more muscle relaxation. The group held for 3 hours recorded the lowest values of chewiness and gumminess, owing to muscle fiber degradation as well as breakdown of proteins.

Table 3

Texture analysis of meat

Attribute	1 Hour	2 Hours	3 Hours	p value
Texture adhesiveness	-0.03 ± 0.13^{b}	0.68 ± 0.69^{a}	0.45 ± 0.39^{a}	0.001
Texture chewiness	40.53 ± 33.63^{a}	16.23 ± 8.20^{b}	9.25 ± 8.30^{b}	0.001
Texture springiness	27.04 ± 17.10^{a}	28.23 ± 8.32^{a}	6.23 ± 4.04^{b}	0.001
Texture gumminess	87.00 ± 35.05^{a}	7.48 ± 55.69^{b}	47.25 ± 54.41^{ab}	0.001
Texture cohesiveness	1.00 ± 0.47^{a}	0.04 ± 0.49^{b}	0.22 ± 0.57^{b}	0.001

Note. Values are expressed as mean ± standard deviation. Means within the same row followed by different superscript letters differ significantly at $p < 0.05$.

Sensory Evaluation

Sensory evaluation of broiler breast meat indicated notable differences in tenderness, juiciness, taste, and overall acceptability based on pre-slaughter holding times (Figure 2). The group treated to 2 hours holding time was found to have the highest preference values for tenderness (7.80 ± 0.85), juiciness (6.97 ± 1.19), and overall acceptability (7.67 ± 1.03), revealing that moderate holding times may increase meat quality. The 1 hour holding group, on the other hand, was found to have the highest preference for taste (7.53 ± 1.28), while the 3 hours holding group was found to score lowest on most sensory attributes, proving that extended holding times have negative impacts on sensory quality.

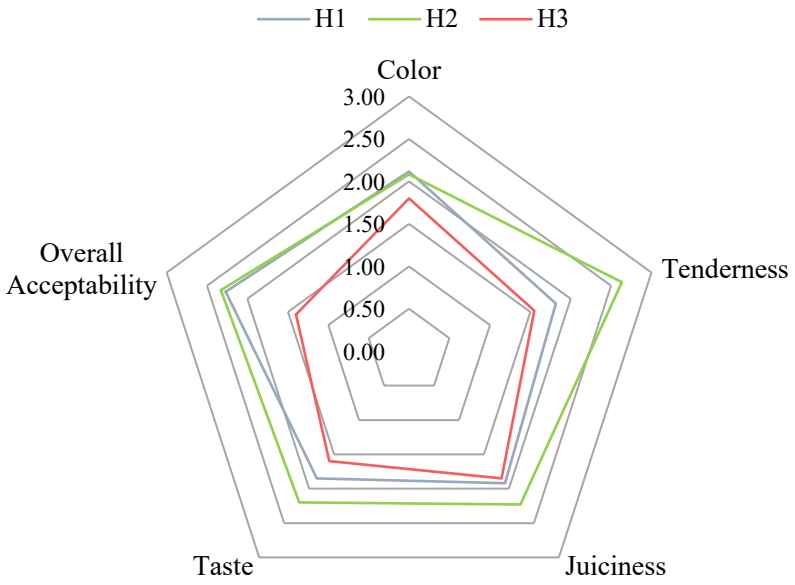

Figure 2. *Sensory Evaluation Graph*

Discussion

The proximate analysis indicated significant differences in moisture content, ash content, and levels of crude protein among the three different pre-slaughter holding times. These results indicate that shorter holding times are likely to promote protein retention, while longer holding times are led to changing the nutrient content, specifically in regard to moisture and ash content. The findings are consistent with those in previous studies by Ali et al. (2007), who reported similar trends in moisture content, and those by Qiao et al. (2002), who recorded an increase in ash content related to longer holding times. The observed differences in protein retention are consistent with the findings of Barbut (1997), who reported that longer holding could cause broiler muscle degradation, leading to protein loss.

According to the physical properties analysis, results are aligned with what has been established by Fletcher et al. (2000), who reported that broiler meat pH levels are invariant regardless of varied pre-slaughter holding conditions. Such consistency implies that the period of holding has no significant impact on the acidification process in muscle tissue. Gholami et al. (2020), who stated that there are minor increases in drip loss associated with longer pre-slaughter holding times, suggesting that water holding might be slightly influenced by longer holding times.

Above cooking loss proved that shorter holding times contribute to more moisture being lost during cooking, a fact that agrees with Barbut (1997), who emphasized how muscle structure integrity dictates water retention during cooking.

The color's parameters trend indicates that shorter holding times are associated with higher brightness in the meat, which could be due to the reduction of oxidative changes in the muscle (Barbut, 1997). In contrast, the redness (a) and yellowness (b) parameters showed no significant differences, which could mean that these color parameters are relatively less sensitive to the holding time. Textural Parameters findings are in agreement with those of Fletcher et al. (2000) as well as Masoumi et al. (2018), who found that a shorter holding time enhances muscle structure, while longer holding times have negative impacts on texture quality through protein denaturation. Sensory evaluation results were agreement with observations by Fletcher et al. (2000) and Barbut (1997), who argued that muscle relaxation, as well as water holding, during medium holding times, benefit meat tenderness, as well as overall acceptability.

Conclusion and Recommendation

This study assessed the effects of different pre-slaughter holding times (1 hour, 2 hours, and 3 hours) on meat quality and sensory attributes of Cobb 500 broiler chickens. The results revealed that holding time was a critical factor influencing physicochemical composition, texture, and sensory properties. A 1-hour holding time increased moisture and protein content, whereas a 3-hour holding time was linked to increased ash content. Nevertheless, pH levels were uniform among the groups, but longer holding times were linked to lower cooking losses and darkening of meat color. Texture assessment revealed higher firmness in 1-hour-held meat, but tenderness and springiness increased with 2 hours of holding time. Sensory panels ranked 2-hour-held meat highest in overall acceptability, tenderness, and juiciness ratings. Ultimately, 2 hours of pre-slaughter holding time was found optimal for balancing physicochemical and sensory qualities, making this option most desirable in commercial poultry production.

Acknowledgements

The authors acknowledge the support provided by the laboratory staff members of the Department of Biosystems Technology, South Eastern University of Sri Lanka: Mr. Rifaitheen (Technical Officer), Mr. IL Mohamed Anas, and Mr. MAC Mohamed Riyal. The authors would like to thank the Department of Biosystem Technology, University of Sri Jayewardenepura, Sri Lanka.

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