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The Influence of Wet Aging on pH, Meat Color, Fat Color and Water Holding Capacity of Bali Beef from Traditional Slaughterhouses in Lombok

Baik Mesy Darita Fitriani[1], Dahlanuddin[2*], Fahrullah[3], Bulkaini[3], M Ashari[4], Ikhwan Firhamsah[4], Zaid Al Gifari[4]

[1]Management of Livestock Resources, University of Mataram, Mataram, Indonesia
[2]Department of Animal Nutrition, University of Mataram, Mataram, Indonesia
[3]Department of Animal Products Technology and Processing, University of Mataram, Mataram, Indonesia
[4]Departemnt of Animal Production, University of Mataram, Mataram, Indonesia
[*]e-mail: dahlanuddin@unram.ac.id

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Abstract: Beef quality plays a vital role in ensuring consumer satisfaction and market competitiveness, particularly in regions where traditional slaughtering practices remain prevalent. This study aimed to evaluate the physical quality of Bali beef obtained from traditional slaughterhouses on Lombok Island and to determine the effect of wet aging on meat quality. The experiment used longissimus dorsi muscle samples from 1 to 3-year-old male Bali cattle. Physical parameters analyzed included pH, meat color, fat color, and water-holding capacity (WHC). Data were analyzed using a Factorial Completely Randomized Design followed by Duncan's Multiple Range Test. Results showed that wet aging had a significant effect ($p<0.05$) on most physical parameters. The pH decreased from 5.85 to 5.57, meat color became slightly darker due to myoglobin oxidation, and fat color became lighter under vacuum conditions. WHC increased from 47.13% to 50.34%, indicating improved water retention. Based on these findings, it can be concluded that beef from traditional slaughterhouses in Lombok still meets the quality standards of fresh meat. Furthermore, the 21-day wet aging process significantly enhanced the physical quality of Bali beef without causing adverse effects, demonstrating its potential as a practical post-slaughter treatment to improve the competitiveness of local beef products.

Keywords: Aging; Balinese Beef Quality; Slaughter Houses in Lombok.

Introduction

Meat is one of the most valuable livestock products, as it serves as a major source of animal protein for human consumption [1]. Meat quality is a crucial attribute that determines its nutritional value, shelf life, safety, and consumer acceptance. In general, meat quality can be assessed through physical, organoleptic, chemical, and microbiological characteristics, which are influenced by animal condition, management system, slaughtering methods, and post-slaughter handling [2]. The role of slaughterhouses (RPH) is therefore essential, as their operational procedures, hygiene standards, and infrastructure directly affect the final quality of meat [3].

On Lombok Island, most local cattle, including Bali cattle, are slaughtered in traditional RPH or community-owned slaughterhouses (TPH). These traditional systems face significant challenges, including limited facilities, suboptimal hygiene standards, and slaughtering practices that often disregard animal welfare principles. Forced restraint methods and prolonged slaughter processes may cause stress, leading to deterioration in both physical and microbiological quality of meat. This issue is particularly critical given the rapid development of the tourism sector in Lombok, where hotels, resorts, and fine-dining restaurants demand consistent premium-quality meat. Consequently, imported beef remains a preferred choice for the modern market, as it is perceived to be more hygienic and compliant with international standards [4].

To address these challenges, one potential approach is the application of *aging* (meat maturation) as a post-slaughter treatment. *Aging* has been widely reported to improve meat's physical quality, particularly tenderness, color, and flavor, while also reducing microbial load under controlled conditions ([5];[6]). Moreover, research by [7] and [8] highlights that local beef from traditional RPH typically exhibits lower sensory quality and shorter shelf life compared to meat processed under controlled modern abattoir systems. Despite these findings, there remains a lack of empirical evidence evaluating post-slaughter interventions, such as controlled aging (maturation), as a strategy to enhance the physical and microbial quality of locally processed beef, particularly for Bali cattle.

However, limited research has explored its application in tropical, small-scale, and low-technology slaughtering environments, such as those in Lombok.

The novelty of this study lies in its comprehensive assessment of both the physical characteristics of Bali beef slaughtered in traditional RPH on Lombok Island, before and after the aging process. This research is expected to provide scientific evidence on how aging may enhance the competitiveness of local beef against imported products, while also serving as valuable input for policymakers and industry stakeholders to improve hygiene standards and facilities in traditional RPH. Hence, this study is not only

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academically relevant but also practically significant in strengthening the market position of local beef in modern and premium segments.

Research Methods

Time and Location of the Study

The study was conducted from May to September 2025. Sampling was carried out at five traditional slaughterhouses (two public slaughterhouses and three privately owned slaughter points) located in Lombok (Mataram City, West Lombok, and Central Lombok). Physical quality assessments (pH, meat color, fat color and Water Holding Capacity) were performed at the Biotechnology and Animal Product Laboratory and the Animal Nutrition and Feed Science Laboratory, Faculty of Animal Science, University of Mataram.

Research Design

This study employed an experimental design using a Factorial Completely Randomized Design (CRD) with two main factors: (1) slaughterhouse type and (2) aging treatment (fresh vs. 21-day wet-aged meat). Each treatment combination was replicated three times, resulting in a total of 30 observations. This design was chosen to evaluate the effect of slaughterhouse condition and post-slaughter aging on the physical quality of Bali beef. The study followed the general procedures for meat quality evaluation as described by [9].

Research Materials

The primary material of this study was meat obtained from five male Bali cattle aged between 1–3 years (with two or four permanent incisor replacements) and a Body Condition Score (BCS) of approximately 3–4. Samples were collected from the *Longissimus dorsi* muscle in the loin area (between the short loin and sirloin), with 2 kg of meat obtained per sample. A total of 30 samples were collected (five from each slaughterhouse/slaughter point).

Sampling was conducted using a purposive sampling method based on active slaughterhouses/slaughter points. Samples were immediately transported to the laboratory for testing. Part of the samples was tested in fresh condition (before aging), while the rest underwent a wet aging process for 21 days at temperatures below 4 °C prior to subsequent testing.

Research Procedure

This study compared the physical quality of fresh beef (before aging) with beef that had undergone wet aging for 21 days.

Physical Tests

1. pH Measurement
   The pH of both fresh and aged beef samples was measured using a meat pH meter (Hanna Instrument) by inserting the cathode directly into the sample until the digital reading stabilized (Hajrawati et al., 2016).
2. Meat Color
   Meat color was evaluated by matching the internal surface color of the sample against the Indonesian National Standard (SNI: 3932:2008) for Beef Carcass and Meat Quality Standards. The color score ranged from 1 (light pink) to 9 (dark red), with higher scores indicating darker coloration.
3. Fat Color
   Fat color was assessed on subcutaneous fat under light and compared with the fat color standards from SNI: 3932:2008. The scoring system ranged from 1 (white) to 9 (yellow).
4. Water Holding Capacity
   The water holding capacity (WHC) of Bali cattle beef was determined using the Hamm method [10], consisting of two stages: free water content and total water content analysis. Free water was measured by weighing 0.3 g of meat sample, placing it on filter paper between two glass plates, and pressing with a 35 kg load for 5 minutes. The wet area was traced on mica plastic and its surface calculated using millimeter block paper. The total water content was determined by the Soxhlet method (AOAC, 2007), in which 2 g of sample was dried in a porcelain crucible at 100–105°C for 5 hours until a constant weight was achieved. WHC was then calculated as the percentage of bound water by comparing free water and total water values.

Data Analysis

Data were analyzed using a two-way ANOVA under a Factorial CRD framework to evaluate the main and interaction effects of slaughterhouse type and aging treatment. When significant differences were detected ($p < 0.05$), means were compared using Duncan's Multiple Range Test (DMRT) with the help of IBM SPSS Statistics v.25. Normality and homogeneity of variance were tested before analysis (Shapiro–Wilk and Levene's test). All data are presented as mean ± standard deviation (SD).

Results and Discussion

pH

Table 1. pH values of beef before and after wet aging

Slaughterhouse	Aging		Avarage
	Before	After	
RPH 1	6.05±0.14	5.61±0.18	5.83^{b}
RPH 2	6.15±0.27	5.59±0.25	5.87^{b}
RPH 3	5.96±0.50	5.58±0.14	5.77^{ab}
TPH 1	5.61±0.11	5.52±0.11	5.57^{a}
TPH 2	5.77±0.11	5.58±0.23	5.68^{ab}
TPH 3	5.54±0.31	5.53±0.15	5.54^{a}
Average	5.85^{b}	5.57^{a}	

Note: Different superscripts within the same row or column indicate significant differences ($p<0.01$).

The analysis (Table 1) revealed highly significant differences ($P < 0.01$) in meat pH values among slaughterhouse locations, indicating that variations in slaughtering and handling conditions had a substantial impact on the final meat quality. No interaction between treatments was observed, suggesting that the aging process had a consistent influence across all locations.

Before aging, the pH values ranged from 6.15 to 5.54, while after aging they decreased to 5.59-5.52. The highly significant p-value ($P < 0.01$) confirms that the decline in pH was not due to random variation but to a consistent biochemical process that occurred during aging. The decrease in pH reflects the conversion of muscle glycogen to lactic acid, a natural process that occurs during postmortem glycolysis and contributes to improved tenderness and shelf stability. These results demonstrate that the aging process effectively promotes biochemical stabilization of the meat, regardless of the slaughterhouse origin. This aligns with [11], who noted that meat pH normally decreases from 7.0 immediately after slaughter to 5.4-5.8 within 6-8 hours postmortem due to rigor mortis. [12] further emphasized that glycogen-driven glycolysis postmortem produces lactic acid, lowering muscle pH, while [5] stated that the ultimate pH depends on lactic acid accumulation in muscles. According to [13], the lowest attainable pH after rigor mortis is 5.1, while values above 6.2 favor bacterial growth.

Duncan's test showed the highest mean pH at RPH 2 (5.87) and the lowest at TPH 3 (5.54). RPH 1 differed significantly ($P<0.01$) from TPH 1 and TPH 3, but not from RPH 2, RPH 3, and TPH 2. These differences may be attributed to variations in antemortem and postmortem handling, including feeding, fasting, and stress management [14]. Stressors such as hunger, high environmental temperatures, fear, or injury can alter muscle metabolism (Rambu et al., 2016), affecting postmortem pH dynamics.

Further results showed a highly significant reduction ($P<0.01$) between pre- and post-aging pH, with averages declining from 5.85 to 5.57. This supports findings by [15] that aging at 4 °C reduces lamb meat pH, and dry aging enhances proteolysis and tenderness. Optimal ultimate pH should remain between 5.5–5.8 [16], as confirmed by [17], who explained that aging alters myofibrillar proteins and collagen, influencing muscle structure and water-holding capacity.

The ultimate pH is reached when glycogen reserves are depleted or glycolytic enzymes become inactive at low pH, usually stabilizing around 5.5 [18]. Meat pH rarely drops below 5.3 because glycolytic enzymes are inhibited at this level. Variations are influenced by intrinsic factors such as species, muscle type, and glycogen levels, as well as extrinsic factors including environmental temperature, feeding, and pre-slaughter stress [19]. Thus, effective pre- and post-slaughter management, combined with proper aging, is crucial to ensure optimal meat quality, tenderness, and safety ([20];[21]).

Meat Color

Meat color is a crucial physical attribute determining both meat quality and freshness. In this study, color evaluation was based on SNI 3932:2008 standards, with a scoring system ranging from 1 (light pink) to 9 (dark red). Analysis (Table 2) showed that slaughterhouse (RPH) location had no significant effect on meat color ($P>0.05$), with the highest average score recorded at RPH 2 (6.80) and the lowest at RPH 1 (4.40). Both fell within quality grade II, categorized as dark red meat. According to [22], meat color is influenced by factors such as diet, breed, age, sex, stress, pH, and oxygen, darker meat is typically associated with higher postmortem pH, greater water-holding capacity, and sticky texture.

Table 2. Meat color values before and after aging

Slaughterhouses	Aging		Average
	Before	After	
RPH 1	3.00±1.22	5.80±1.09	4.40
RPH 2	8.00±1.00	5.60±1.14	6.80
RPH 3	6.60±2.60	5.60±1.14	6.10
TPH 1	5.80±2.16	5.60±1.14	5.70
TPH 2	6.40±0.89	5.60±1.51	6.00
TPH 3	6.60±3.28	5.20±0.83	5.90
Average	6.07^{b}	5.57^{a}	

Note: Different superscripts in the same row and column indicate significant differences ($p<0.01$).

Further noted that cattle fed low-energy diets produce darker red meat, whereas those on medium- and high-energy rations yield brighter red meat, highlighting the importance of dietary energy content [23] . The findings of this study were lower than those of [24], who reported that Bali cattle had darker meat with an average score of 9.00, suggesting low muscle glycogen reserves, poor feeding energy, and suboptimal slaughter handling. This indicates that both nutritional and pre-slaughter management practices play an important role in determining meat color.

Statistical analysis (Table 2) revealed a significant effect of aging on meat color ($P<0.01$). Duncan's test showed average scores declined from 6.07 before aging to 5.57 after aging, shifting from bright red (quality I) to a darker shade. These results are consistent with [5], who observed a significant reduction in color score with increasing aging duration, and partially align with [6], who reported a score of 4.88 after 21 days of aging. Variations may be attributed to differences in breed, age, and feeding regimes.

The chemical form of myoglobin pigment largely determines meat color and depends on oxygen concentration and oxidative status. Freshly cut meat initially contains deoxymyoglobin, which turns bright red upon exposure to oxygen, due to the formation of oxymyoglobin. Over time, oxidation of iron in myoglobin produces metmyoglobin, leading to discoloration [25]. Thus, meat color is the result of a complex interaction among biochemical changes, oxygen availability, feeding conditions, and postmortem handling practices.

Figure 1. Meat Color before aging

Figure 2. Meat Color after aging

Fat Color

Table 3. Beef Fat Color Scores Before and After Aging

Slaughterhouses	Aging		Average
	Before	After	
RPH 1	1.40±0.89	5.80±1.09	6.60
RPH 2	8.00±0.00	5.60±0.86	6.80
RPH 3	7.00±0.70	5.60±1.09	6.30
TPH 1	7.20±0.44	5.60±1.14	6.40
TPH 2	6.60±0.89	5.60±1.14	6.10
TPH 3	7.40±1.34	5.20±1.51	6.30
Average	7.27[b]	5.57[a]	

Note: Different superscripts within the same column indicate a significant effect (p<0.01).

Fat color plays an important role in consumer acceptance of beef, as yellow fat is generally less favored in both domestic and export markets compared to white fat [26]. The analysis (Table 3) revealed no significant differences in fat color across slaughterhouse locations (P>0.05), with mean values ranging from 6.10 to 6.80. Based on SNI 3932:2008 standards, the fat color of Bali cattle carcasses in this study was classified as pale yellow. These findings are consistent with [26], who reported similar values for Bali bulls, indicating that pale-yellow fat is common under such feeding and management conditions.

Fat color is influenced by multiple factors, including diet, genetics, age, carcass fat depot, environment, and processing techniques [27]. Yellow pigmentation primarily results from carotenoid accumulation especially β-carotene, the main precursor of vitamin A within adipocytes [24]. Cattle fed predominantly on fresh forage tend to have yellower fat compared to grain-fed cattle, while female and older cattle also exhibit higher levels of yellow pigmentation [28]. In this study, animals were 1-3 years old, which partly explains the pale-yellow fat observed. Since forage-based diets are lower in energy than concentrate-rich diets, fat deposition is limited, affecting not only fat color but also meat tenderness, brightness, and flavor acceptance.

Several studies suggest that fat yellowness can be reduced through dietary manipulation prior to slaughter. Transitioning cattle from fresh pasture to grain- or silage-based diets for 4-10 weeks before slaughter reduces β-carotene levels in blood serum and fat, thereby producing whiter carcass fat [28]. This highlights the role of nutritional management in meeting market preferences for whiter fat, especially in beef export markets where pale fat is often more desirable.

In contrast, aging treatments significantly affected fat color (P<0.01). Mean fat color scores decreased from 7.27 before aging to 5.57 after aging (Table 3). This change is associated with vacuum packaging during the aging process, which creates an oxygen-free environment that prevents lipid oxidation and helps preserve the fresh, pale appearance of fat [29]. These results underscore the combined influence of both feeding strategies and postmortem handling in determining fat color and consumer acceptability.

Figure 3. Fat Color before aging

Figure 4. Fat Color after aging

Water Holding Capacity

Table 4. Water Holding Capacity Values Before and After Aging

Slaughterhouse	Aging (%)		Averag
	Before	After	
RPH 1	38.25±6.30	54.26±4.92	46.26
RPH 2	39.60±5.39	54.29±9.63	46.95
RPH 3	47.65±10.44	47.58±9.10	47.62
TPH 1	51.43±13.84	46.14±2.72	48.79
TPH 2	48.85±5.90	54.87±4.76	51.86
TPH 3	57.01±8.90	44.89±8.18	50.95
Average	47.13	50.34	

Water holding capacity (WHC) is a critical parameter in evaluating the physical quality of meat, particularly in the food industry where processing involves cutting, cooking, grinding, and storage. WHC refers to the ability of meat to retain its intrinsic water content when subjected to external forces during processing [30]. Table 4 presents the average WHC of Bali cattle beef across slaughterhouse locations and before and after aging. Statistical analysis revealed no significant differences between treatments (p > 0.05), with WHC values ranging from 38.25% to 57.01%. The overall mean WHC before aging was 47.13%, which slightly increased to 50.34% after aging. This trend is consistent with [15], who reported that pH decline after rigor mortis leads to the breakdown of actin-myosin complexes, allowing divalent ions (Ca^{2+}, Mg^{2+}) to be replaced by monovalent ions (Na^{+}), creating empty spaces that are subsequently filled by water.

The WHC values in this study fall within the normal range of 20%–60%. However, they were lower compared to previous studies, where Bali cattle beef exhibited WHC values around 66.13% [19] and 66.2% (Merthayasa et al., 2015). This difference may be attributed to the type of muscle used in the present study. The Longissimus dorsi muscle is relatively lean, with lower intramuscular fat content, which tends to limit WHC. Muscles with higher fat content usually have a looser microstructure, providing greater capacity for protein to bind water, thus resulting in higher WHC.

In addition to muscle composition, WHC is influenced by a wide range of factors, including pH, species, age, preslaughter stress, transportation, feeding regime, carcass handling, and aging ([31]; [16]). In the present study, although a significant pH decline was observed after aging, WHC tended to increase rather than decrease, suggesting that the level of protein denaturation was not substantial enough to impair water retention. This finding indicates that aging may enhance meat quality by improving WHC through enzymatic proteolysis that loosens the muscle fiber structure, thereby allowing water to be retained more effectively.

Transport stress may also play an important role in WHC variability among slaughterhouses. [27] reported that Bali cattle subjected to long-distance transportation (up to 1,200 km or 48 hours) without adequate rest experienced body weight losses of up to 9.77% due to stress. Such stress could alter glycogen reserves and postmortem muscle metabolism, ultimately influencing WHC. Providing sufficient rest (8-12 hours) before slaughter is therefore essential to restore physiological balance and minimize adverse effects on meat quality.

Furthermore, WHC is closely related to consumer-perceived meat quality traits such as tenderness, juiciness, and cooking yield [32]. Meat with higher WHC retains more water during cooking, leading to juicier texture and better palatability. Conversely, low WHC results in excessive drip loss, reduced tenderness, and lower sensory acceptance. In commercial practice, variations in WHC can significantly impact market competitiveness, particularly in the premium meat sector, which requires consistency in quality attributes.

Overall, this study confirms that while WHC values of Bali cattle beef from traditional slaughterhouses remain within the normal physiological range, they are relatively lower compared to results from previous studies. This may be explained by differences in muscle type, fat content, preslaughter handling, and postmortem treatment. Importantly, the increase in WHC observed after aging suggests that controlled aging can improve the water retention properties of meat. For local beef industries in Lombok, adopting proper aging practices, minimizing preslaughter stress, and improving slaughterhouse facilities could enhance the physical quality of Bali cattle beef, allowing it to better compete with imported meat in both traditional and premium markets.

Conclusion

Based on the results of the study, it can be concluded that, in terms of physical characteristics (pH, meat color, fat color and Water Holding Capacity), beef from traditional slaughterhouses in Lombok Island still has good quality and falls within the normal range of fresh meat. The 21-day aging process significantly improved the physical quality of local beef, and no negative effects of aging on the physical quality of the meat were detected.

Author's Contribution

Dahlanuddin and Fahrullah conceptualized the study and designed the methodology. Baik Mesy was responsible for data collection and laboratory analysis. Zaid Al Gifari performed data processing, statistical analysis, and drafted the manuscript. Ikhwan Firhamsah contributed to the critical revision of the manuscript and provided overall supervision of the research. All authors read and approved the final version of the manuscript.

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References

[1] H. P. Supriyatin, "Dan Has Luar," 2020.

[2] M. O. A. Sinaga, N. L. P. Sriyani, and D. A. N. I. G. Suarta, "Kualitas Organoleptik Daging Sapi Bali Organolptic Quality of Bali Beef Aging," *J. Ilm. Peternak.*, vol. 4, no. 2, pp. 1–5, 2021.

[3] V. E. Sihombing, I. B. N. Swacita, and I. K. Suada, "Perbandingan Uji Subjektif Kualitas Daging Sapi Bali Produksi Rumah Pemotongan Hewan Gianyar, Klungkung dan Karangasem," *Indones. Med. Veterinus*, vol. 9, no. 1, pp. 99–106, 2020, doi: 10.19087/imv.2020.9.1.99.

[4] S. Anastasya, I. B. N. Swacita, and I. K. Suada, "Perbandingan Kualitas Fisik Objektif Daging Sapi Bali Produksi Rumah Pemotongan Hewan Karangasem, Klungkung, dan Gianyar," *Indones. Med. Veterinus*, vol. 9, no. 3, pp. 361–369, 2020, doi: 10.19087/imv.2020.9.3.361.

[5] P. M. K., N. L. P. SRIYANI, and A. A. OKA, "Physical Quality of Beef Which Is Aging Traditionally," *Maj. Ilm. Peternak.*, vol. 24, no. 2, p. 72, 2021, doi: 10.24843/mip.2021.v24.i02.p04.

[6] V. Bulgaru, L. Popescu, N. Netreba, A. Ghendov-Mosanu, and R. Sturza, "Assessment of Quality Indices and Their Influence on the Texture Profile in the Dry-Aging Process of Beef," *Foods*, vol. 11, no. 10, 2022, doi: 10.3390/foods11101526.

[7] R. Cao *et al.*, "Effects of Different Low-Temperature Storage Methods on the Quality and Processing Characteristics of Fresh Beef," 2023.

[8] V. C. Resconi, M. Campo, A. Guerrero, P. Guarnido-l, G. A. María, and L. Olleta, "Slaughtering of heifers in a local or an industrial abattoir : Animal welfare and meat quality consequences," vol. 259, no. February, 2022.

[9] K. D. Yulianti, R. Priyanto, H. Nuraini, B. Tengah, and B. City, "Physical Characteristics of Three Types of Muscles with Different Aging Times," vol. 11, no. 105, pp. 54–59, 2023.

[10] A. Akbar, E. Abustam, and M. N. Hidayat, "Pengaruh Lama Perendaman Asap Cair KonsentrasiI 10 % dan Lama Penyimpanan Terhadap Daya Ikat Air da Daya Putus Daging," no. June, 2014.

[11] B. Kuntoro, R. R. A. M. Ari, and D. H. Nuraini, "Mutu Fisik Dan Mikrobiologi Daging Sapi Asal Rumah Potong Hewan (Rph) Kota Pekanbaru," *J. Peternak.*, vol. 10, no. 1, pp. 1–8, 2013.

[12] S. Luo *et al.*, "The Impact of MSTN Gene Editing on Meat Quality and Metabolomics: A Comparative Study Among Three Breeds of MSTN-Edited and Non-Edited Cattle," *Animals*, vol. 15, no. 1, pp. 1–14, 2025, doi: 10.3390/ani15010047.

[13] M. A. Tamal, S. Sutikno, and Y. Yance, "Uji Kualitas Daging Sapi Otot Bicep Femoris (Bf) Di Pasar Sangatta Kutai Timur Kalimantan Timur," *Ziraa'Ah Maj. Ilm. Pertan.*, vol. 49, no. 3, p. 505, 2024, doi: 10.31602/zmip.v49i3.14753.

[14] F. Fikri, I. S. Hamid, M. Thohawi, and E. Purnama, "Uji Organoleptis, pH, Uji Eber dan Cemaran Bakteri pada Karkas yang Diisolasi dari Kios di Banyuwangi (Organoleptic Test, pH Test, Eber Test

and Bacterial Contaminant on Carcass that Isolated from Banyuwangi Market)," *J Med Vet*, vol. 1, no. 1, pp. 23–27, 2017, [Online]. Available: http://journal.unair.ac.id

[15] R. Sunarlim and H. Setiyanto, "Aging meat at room and cold temperatures on meat quality and aging loss of sheep carcass," *J. Ilmu Ternak dan Vet.*, vol. 6, no. 1, pp. 51–58, 2014, doi: 10.14334/jitv.v6i1.219.

[16] G. J. Julian and A. M. Sutedja, "Dry Aging pada Daging Sapi dan Babi," *Zigma*, vol. 39, no. 1, pp. 1–12, 2024.

[17] M. Di Paolo *et al.*, "Effects of the Aging Period and Method on the Physicochemical, Microbiological and Rheological Characteristics of Two Cuts of Charolais Beef," *Foods*, vol. 12, no. 3, 2023, doi: 10.3390/foods12030531.

[18] P. Patriani, H. Hafid, E. Mirwandhono, and T. H. Wahyuni, *Teknologi Pengolahan Daging*, no. May. 2020. [Online]. Available: http://repository.pertanian.go.id/handle/123456789/14049%0Ahttp://repository.pertanian.go.id/bitstream/handle/123456789/14049/Teknologi Pengolahan Daging.pdf?sequence=1&isAllowed=y

[19] N. K. Suwiti, N N C. Susilawati, and I B N. Swacita, "Karakteristik fisik daging sapi bali dan wagyu," *Bul. Vet. Udayana*, vol. 9, no. 2, pp. 125–131, 2017, [Online]. Available: http://ojs.unud.ac.id/index.php/buletinvet

[20] R. Rusdimansyah and K. Khasrad, "Kualitas Fisik Daging Sapi Peranakan Simmental dengan Perlakuan Stimulasi Listrik dan Lama Pelayuan yang Berbeda," *J. Peternak. Indones. (Indonesian J. Anim. Sci.*, vol. 14, no. 3, p. 454, 2012, doi: 10.25077/jpi.14.3.454-460.2012.

[21] I. Gramatina, R. Krasnobajs, L. Skudra, and S. Sazonova, "Changes of physical parameters of meat during wet ageing," pp. 61–65, 2019, doi: 10.22616/foodbalt.2019.043.

[22] M. J. Beriain, M. V. Goñi, G. Indurain, M. V. Sarriés, and K. Insausti, "Predicting Longissimus dorsi myoglobin oxidation in aged beef based on early post-mortem colour measurements on the carcass as a colour stability index," *Meat Sci.*, vol. 81, no. 3, pp. 439–445, 2009, doi: 10.1016/j.meatsci.2008.09.009.

[23] R. Priyanto, A. M. Fuah, E. L. Aditia, M. Baihaqi, and M. Ismail, "Improving Productivity and Meat Quality of Local Beef Cattle Through Fattening on Cereals Based Feed with Different Energy Levels," *J. Ilmu Pertan. Indones.*, vol. 20, no. 2, pp. 108–114, 2015, doi: 10.18343/jipi.20.2.108.

[24] P. K. Tahuk, A. A. Dethan, and S. Sio, "Karakteristikwarna daging dan lemak sapi bali jantan yang digemukkan dengan hijauan di peternakan rakyat," *Trop. Anim. Sci. Technol.*, vol. 2, no. 2, pp. 17–25, 2020.

[25] C. Avilés, M. Juárez, I. L. Larsen, A. Rodas-González, and J. L. Aalhus, "Effect of multiple vacuum packs on colour development and stability in beef steaks," *Can. J. Anim. Sci.*, vol. 94, no. 1, pp. 63–69, 2014, doi: 10.4141/CJAS2013-037.

[26] B. Bulkaini, D. Dahlanuddin, T. Ariana, D. Kisworo, M. Maskur, and M. Mastur, "Marbling score, cholesterol, and physical–chemical content of male Bali beef fed fermented pineapple peel," *J. Adv. Vet. Anim. Res.*, vol. 9, no. 3, pp. 419–431, 2022, doi: 10.5455/javar.2022.i610.

[27] S. Setiyono, A. H. A. Kusuma, and R. Rusman, "Effect of Breed, Age, and Sex on Quality of Beef in Special Region of Yogyakarta," *Bul. Peternak.*, vol. 41, no. 2, p. 176, 2017, doi: 10.21059/buletinpeternak.v41i2.9935.

[28] A. Priolo, D. Micol, and J. Agabriel, "Effects of grass feeding systems on ruminant meat colour and flavour. A review," *Anim. Res.*, vol. 50, no. 3, pp. 185–200, 2001, doi: 10.1051/animres:2001125.

[29] I. Albertos, A. B. Martin-Diana, I. Jaime, A. M. Diez, and D. Rico, "Protective role of vacuum vs. atmospheric frying on PUFA balance and lipid oxidation," *Innov. Food Sci. Emerg. Technol.*, vol. 36, pp. 336–342, 2016, doi: 10.1016/j.ifset.2016.07.006.

[30] V. A. Mendrofa, R. Priyanto, and M. Pascasarjana Program Studi Ilmu Produksi dan Teknologi Peternakan, "Sifat Fisik dan Mikroanatomi Daging Kerbau dan Sapi pada Umur yang Berbeda Physical and Microanatomycal Characteristics of Meat from Buffalo and Catlle on Different Age," vol. 04, no. 2, p. 325, 2016.

[31] Jamhari, "Perubahan_Sifat_Fisik_dan_Organoleptik_Daging_Sapi," *Buletin Peternakan*, vol. 24 (1). pp. 43–50, 2000.

[32] O. A. Lapase, "Kualitas fisik (daya ikat air, susut masak, dan keempukan) daging paha ayam sentul akibat lama perebusan," vol. 2, pp. 306–312, 2024.