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Evaluation of beef Characteristics during Preservation

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***Abstract* —** *pH is one of the most important indicators for beef evaluation. The objective of this study was to examine the changes in the pH value of beef carcass from Vietnamese yellow cattle and Brahman crossbreeds cattle. The beef samples used for the review was the tenderloin (from the 7-9 vertebra) and thigh meat. The meat was collected at the slaughterhouse, then pH was measured after 1 hour, 12 hours, 48 hours and 8 days from the time of slaughter. The results showed that the pH of tenderloin and thigh between two groups of cattle was quite similar to each other during the time of collection and preservation. The pH value of thigh after 1h harvest between two groups of Vietnamese yellow cattle (6.47 ± 0.01) and Brahman crossbreeds cattle (6,632 ± 0.0102) was similar, which was different from that of the tenderloin (6,944 ± 9.27E-03a) compared to Brahman crossbreds (6,628 ± 3.74E-03a). The pH value of tenderloin and thigh decreased rapidly after 12 hours of preservation in both Vietnamese yellow cattle and Brahman crossbreeds cattle and continued to decline rapidly after 48 hours. However, after 8 days of preservation, the pH value of the tenderloin of the two groups increased slightly, in the Vietnamese yellow cattle group was 5.514 ± 4.00E-03 and the Brahman crossbreeds cattle group was 5.578 ± 0.025 (P ≤ 0.05). For thighs, only the pH value of Vietnamese yellow cattle was slightly increased (5,474 ± 2.45E-03); whereas the pH of the thigh of Brahman crossbreds after 8 days of preservation was not different from that of 48 hours of preservation (5,396 ± 2.45E-03). The pH value of the tenderloin (5.406 ± 5.10E-03) and thigh meat (5.41 ± 4.47E-03) of Brahman crossbreeds are within acceptable standards of the French Institute for Animal Husbandry. However, in the Vietnamese yellow cattle group, the pH of the tenderloin (5.28 ± 7.07E-03) and thigh meat (5,308 ± 3.74E-03) was lower than 48 hours after preservation.*

***Keywords*— Brahman crossbreeds cattle, pH, Vietnamese yellow cattle, preservation.**

I. INTRODUCTION

Nowadays, in addition to meat productivity, meat quality has become a top concern of beef production establishments. According to the assessment criteria of experts, five basic attributes affect the decision of consumers when choosing meat is the taste, softness, safety, color, appearance and sweetness [1]. Achieving high quality of beef is extremely important in production and processing. For livestock-based industries, improvement of beef quality is a key to maintaining and increasing global market share [1]. pH can significantly affect meat quality parameters, including color, water holding capacity and shelf life. As a consequence, pH has been widely used as an indicator of potential meat quality [2,3]. In addition, the softness of meat is also associated with pH; high-pH meat will quickly become stiffer than low-pH meat in the process of aging. The highest quality meat products tend to reduce the pH in the range of 5.7 to 6.0. pH changes affect the water capacity to retain water. Low pH results in meat protein reduced water holding capacity and lighter color. Conversely, higher pH will give a darker color and less dehydration [4,5]. Water holding capacity is defined as the ability to conserve water in muscle after animal death under the influence of external pressure (eg, gravity, heat). One of the most common meat quality problems is high moisture loss in fresh produce and processing. Proteins and water-soluble vitamins are also lost along with moisture. Water holding capacity may also affect processing characteristics [6]. Low-water retention meats tend to produce poor quality products [7].

Vietnam has made many breeding programs to improve the reproductive performance, growth as well as the quality of

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the beef breed. Crossbreeding was performed with exotic cows such as Zebu, Brahman, Red Sind, Holstein, and Charolais to produce improved quality crossbreds [8,9,10]. The above-mentioned hybridization methods have brought high economic efficiency and improved beef yield. Current studies focus on evaluating beef quality through parameters such as dry matter, protein, fat, total minerals, calcium, phosphorus ... [11]. In this study, we focused on the evaluation of beef quality through a number of values directly related to beef preservation and processing, ie the pH and dehydration of meat from Vietnamese yellow cows and Brahman crossbred cows.

II. MATERIALS AND METHODS

Sample collection

In this study, we evaluated the quality of meat in Vietnamese yellow cows and Brahman crossbred cows. Five samples of each cow group were collected. Meat samples were from loin (from ribs 7-9) and thighs. Meat is collected at the slaughterhouses, with the identification number for each sample. Sample container was kept at 4ºC. The pH index was determined in loin and thighs after 1 hour, 12 hours, 48 hours and 8 days. Parameters of meat dehydration during preservation and processing were identified in the loin after 12 hours and 48 hours.

pH evaluation

The evaluation of beef pH value was performed by Orion 420Aplus pH meter (Thermo Scientific). The pH of the loin and thigh is determined after 1 hour, 12 hours, 48 hours, 8 days. For each beef sample, 2 grams of meat was collected and transferred to the 5 ml tube and then cut to a fine paste. Meat pH measurement was performed at room temperature. The pH electrode was washed with distilled water and cleaned. The pH value of the beef was determined by immersing the electrode in the sample tube containing the finely chopped meats, followed by pressing and turning the electrode gently to simmer the electrode. The parameter displayed on the main screen is the pH value to be searched. After the measurement, the electrode was cleaned and the next sample of meat was measured.

Evaluation of meat dehydration during preservation

Dehydration rate during preservation (%) was determined on laboratory preserved samples after 12 hours and 48 hours. The formula is as follows:

$$\textit{Dehydration rate during preservation} = \frac{P1 - P2}{P1} \times 100$$

P1: Sample weight before preservation

P2: Sample weight after preservation

Evaluation of meat dehydration during processing

Dehydration rate during processing (%) was determined on laboratory preserved samples after 12 hours and 48 hours. The formula is as follows:

$$\textit{Dehydration rate during processing} = \frac{P1 - P2}{P1} \times 100$$

P1: Sample weight before storage

P2: Sample weight after storage

Statistical analysis

The experiments were triplicated. Data were analyzed for statistical significance by one-way ANOVA where $P < 0.05$ was considered statistically significant.

III. RESULTS

pH evaluation

The pH value of the loin meat between two groups of the cow was almost no difference between the time of collection and storage (Table 1). However, the pH value of the loin of Vietnamese yellow cows at 1 hour after harvesting had a higher pH value than that of Brahman-crossbred cows. The pH of loin was reduced rapidly after 12 hours of storage ($P \leq 0.05$) in both Vietnamese yellow cows (6.05 ± 0.0114) and Brahman crossbred cows (6.016 ± 6.78E-03). After 48 hours of storage, the pH of the loin of two groups continued to decline rapidly. pH of the Vietnamese yellow group was 5.28 ± 7.07E-03 and the Brahman crossbred group was 5.406 ± 5.10E-03. However, after 8 days of storage, the pH value of loin of these two groups increased slightly, in the Vietnamese yellow group was 5.514 ± 4.00E-03 and the Brahman crossbred group was 5.578 ± 0.025 ($P \leq 0.05$). This suggests that storage at 4°C affects the pH value of the loin of both Vietnamese yellow and Brahman crossbred cows.

Table 1. pH value of loin from Vietnamese yellow and Brahman crossbred cows.

Time of preservation	Brahman crossbred cows	Vietnamese yellow cows
1h	6.628 ± 3.74E-03[a]	6.944 ± 9.27E-03[a]
12h	6.016 ± 6.78E-03[b]	6.05 ± 0.0114[b]
48h	5.406 ± 5.10E-03[c]	5.28 ± 7.07E-03[c]
8 days	5.514 ± 4.00E-03[d]	5.578 ± 0.025[d]

a,b,c,d: significant differences, P≤0.05

The pH value of the thigh meat was not significantly different at the time of collection and storage between these

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two groups of cattle (Table 2). The pH value of thigh meat after 1 hour harvesting between Vietnamese yellow cows (6.47 ± 0.01) and Brahman crossbred cows (6,632 ± 0.0102) was similar, which was different from that of the loin. The pH of the thigh meat also decreased rapidly after 12 hours of storage ($P \leq 0.05$) in both Vietnamese yellow cows (5,956 ± 6.78E-03) and Brahman crossbred cows (6.064 ± 8.72E-03).

Like the loin, the pH value of thigh meat of the two groups of cattle continued to decline rapidly after 48 hours of storage, in the Vietnamese yellow group was 5,308 ± 3.74E-03 and the Brahman crossbred group was 5.41 ± 4.47E-03. After 8 days of preservation, only pH value of thigh meat of Vietnamese yellow cattle increased slightly (5,474 ± 2.45E-03). The pH of thigh meat of Brahman crossbred group after 8 days of preservation was not different from that of 48 hours of storage (5,396 ± 2.45E-03).

Table 2. pH value of thigh meat from Brahman crossbred cows and Vietnamese yellow cows.

Time of preservation	Brahman crossbred cows	Vietnamese yellow cows
1h	6.632 ± 0.0102[a]	6.47 ± 0.01[a]
12h	6.064 ± 8.72E-03[b]	5.956 ± 6.78E-03[b]
48h	5.41 ± 4.47E-03[c]	5.308 ± 3.74E-03[c]
8 days	5.396 ± 2.45E-03[c]	5.474 ± 2.45E-03[d]

a,b,c,d: significant differences, P≤0.05

Evaluation of dehydration during preservation

The dehydration rate of the loin increased with the preservation time in both Vietnamese yellow and Brahman crossbred cows (Table 3). The preservation dehydration rate of loin meat is lowest after 12 hours, when the dehydration rate in beef cattle was 2,222 ± 0.6054% and the Brahman breed was 1.5284 ± 0.6198%. After 48 hours of preservation, the dehydration rate increased by approximately 3 times compared to 12 hours of storage in Brahman crossbreds (4.9166 ± 0.5095%) and Vietnamese yellow cows (5.113 ± 0.9312%). During preservation, the rate of dehydration of Vietnamese yellow beef was higher than that of Brahman crossbreds. Greater dehydration can cause the pH value of the loin of Vietnamese yellow group to be lower than the Brahman crossbred group after 12 and 48 hours.

Table.3: Dehydration rate during preservation of loin

Time of preservation	Brahman crossbred cows	Vietnamese yellow cows
12h	1.5284 ± 0.6198[a]	2.222 ± 0.6054[a]
48h	4.9166 ± 0.5095[b]	5.113 ± 0.9312[b]

a,b: significant differences, P≤0.05

Evaluation of dehydration during processing

In Brahman crossbred group, the dehydration rate of loin after 12 hours (13.2424 ± 2.3676%) and 48 hours (16.9552 ± 1.8444%) were not statistically different (Table 4). In the Vietnamese yellow group, the dehydration rate of loin during processing after 12 hours (9.4882 ± 1.0009%) and 48 hours (17.4039 ± 2.5865%) was statistically different. Dehydration rate after 48 hours is higher than that after 12 hours.

Table.4: Dehydration rate during processing of loin

Time of preservation	Brahman crossbred cows	Vietnamese yellow cows
12h	13.2424 ± 2.3676[a]	9.4882 ± 1.0009[a]
48h	16.9552 ± 1.8444[a]	17.4039 ± 2.5865[b]

a,b: significant differences, P≤0.05

IV. DISCUSSION

Some studies on beef quality assessment in Vietnam have been conducted on some breeds such as Lai Sind, Brahman x Lai Sind, or Charolais x Lai Sind [12]. After 1 hour of collection, the pH value of the Lai Sind, Brahman x Lai Sind, or Charolais x Lai Sind varieties was 6.69 ± 0.11, 6.73 ± 0.09, 6.67 ± 0.04. The meat pH values of the above mentioned breeds were equivalent to the pH value of Brahman crossbreeds that were not performed in this study (6,628 ± 3.74E-03). However, all the pH values of the crossbreds in the study by Pham et al., as well as the Brahman crossbreds were lower than the pH values of Vietnamese yellow cows (6.944 ± 9.27E-03). After 12 hours of preservation, the meat pH of Lai Sind, Brahman x Lai Sind, or Charolais x Lai Sind was 5.92 ± 0.09, 5.84 ± 0.10, 5.92 ± 0.11 respectively [12]. This value is equivalent to the pH value of Brahman crossbreds (6.016 ± 6.78E-03) and Vietnamese yellow cows (6.05 ± 0.0114) in our study. After 48 hours of preservation, the meat pH value of the crossbred cattle in the study of Pham and his colleagues, as well as our group, had the same reduction. Brahman crossbreds group in our study had a pH value of 5.406 ± 5.10E-03 after 48 hours of preservation, crossbred cattle in

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the study by Pham et al. including Lai Sind, Brahman x Lai Sind , or Charolais x Lai Sind respectively decreased by 5.52 ± 0.04, 5.60 ± 0.05, 5.69 ± 0.13 [12].

After slaughter, the meat muscle of the cattle will be weakened, the moisture content is low, the pH of the meat will decrease to about 6.0 after 2.2 hours to 13.6 hours of slaughter [13]. Oxygen transport into the body stops, resulting in decreased aerobic metabolism, which is gradually replaced by an anaerobic stage. The process of glycogen breakdown will accumulate lactic acid, reducing the pH from 7 to 5.7 to 5.3 after 24 hours when beef is stored at 4°C [14]. This pH value is close to the isoelectric point of the fiber protein (pH = 5.0-5.5). The pH value of loin after 48 hours of preservation must meet some criteria of the French Livestock Institute [15]. The stable pH value is normally in the range of 5.40-5.59, which is the standard meat limit [16]. The loin meat is considered dark when its pH is greater than 5.85. Research results show that the pH value of loin 5.406 ± 5.10E-03 (5.406 ± 5.10E-03) and the thigh (5.41 ± 4.47E-03) of Brahman crossbreeds are within acceptable standards of the French Livestock Institute. However, in the Vietnamese yellow group, the pH value of the loin (5.28 ± 7.07E-03) and the thigh (5.308 ± 3.74E-03) was lower than this standard after 48 hours of preservation. In addition, the dehydration rate of Vietnamese yellow cow loin was higher than that of Brahman crossbreds after 12 hours and 48 hours of preservation, thus lowering the water holding capacity or moisture content of Vietnamese yellow beef loin compared to Brahman crossbreds. The results of the evaluation of pH and water holding capacity of beef loin showed that the quality of Vietnamese yellow beef loin was lower than that of Brahman crossbreds.

V. CONCLUSIONS

In this study, we evaluated the changes in pH value during beef preservation in Vietnamese yellow and Brahman crossbred cows. The pH value of the two breeds is within the standard set by the French Livestock Institute. The water holding capacity of Vietnamese yellow cows was lower than Brahman crossbred cows, thus the quality of Vietnamese beef loin was lower than that of Brahman crossbreds.

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