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Research Article
Effect of Cattle Breeds on the Meat Quality of Longissimus Dorsi Muscles

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Abstract

Objective: This study aimed to investigate the effects of cattle breed on meat quality. **Methodology:** The beef used in this study came from four breeds of cattle, Bali, Pesisir, Simmental cross and Brahman cross, aged 2.5-3 years with the same body scores. The muscle sample used was the longissimus dorsi muscle. The breed of cattle (Bali, Pesisir, Simmental cross and Brahman cross) is designed as a treatment factor and meat was sampled from each animal as a group. The parameters measured were pH, tenderness (shear force), cooking loss, water holding capacity, water content, protein and fat contents. The data obtained were processed using analysis of variance (ANOVA) as well as Duncan's Multiply Range Test (DMRT). **Results:** The results showed that cattle breed has an effect on the average pH, tenderness (shear force), cooking loss, water holding capacity, water content, protein and fat contents of the longissimus dorsi muscle. Pesisir cattle has the lowest cooking loss and the highest protein content. **Conclusion:** The breed of cattle effects meat quality of the longissimus dorsi muscle.

Key words: Meat quality, water holding capacity, shear force, cooking loss, protein content

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Factors affecting the quality of meat can be grouped into three periods: Before, during and after slaughter. Factors affecting meat quality prior to slaughter are cattle breed, genetic and environmental factors[1], age, sex and slaughter weight[2]. Some indicators that determine the quality of meat are pH, water holding capacity, cooking losses, meat tenderness and chemical content such as levels of protein, fat and fatty acid composition. Different breeds of cattle and their interaction with breed weight affect the tenderness of beef[3].

The chemical composition of meat depends on the species and condition of the animal, the type of meat carcass, the process of preservation, storage and it is also influenced by the fat content[4]. The chemical composition of meat in general can be estimated at approximately 75% water, 19% protein, 2.5% fat, 1.2% carbohydrate, 2.3% non-protein fat-soluble substances including 1.65% nitrogenous, 0.65% inorganic substances and minimal amounts of fat and water soluble vitamins[5].

Genetic factors include gender, muscle type and the individual animal, while environmental factors comprise nutrients and animal feed, including additives. Additionally, handling of cattle before and after slaughter influences physiological factors that can affect the chemical composition of meat. Cows that mature faster typically accumulate fat more quickly than slow-maturing cattle. The nutritional value of meat can be deduced from the dry matter. Protein is the largest dry matter component of meat, while fat is a high-energy food and every gram of fat provides a substantial amount of energy.

Currently, there are several breeds of cattle that were developed and maintained as livestock in Indonesia, including Pesisir, Bali, Simmental and Brahman cross-breed cattle. Some breeds differ in mature body weight, system of management and even feed source, such as Pesisir cattle, which are raised in an extensive system with low quality feedstuffs, while Simmental cross-breeds and other imported cattle are reared intensively and fed with concentrate. The diverse breeds raised by farmers prompted the assessment of meat quality from different breeds of cattle. The purpose of this study was to determine the effect of cattle breed on meat quality parameters such as pH, water holding capacity, cooking losses, tenderness, color, water content, protein content and fat content.

MATERIALS AND METHODS

This study assesses the meat from the longissimus dorsi muscle from Bali, Pesisir, Simmental cross and Brahman cross cattle within the same physiological age. This study uses a randomized block design. The breed of cattle (Bali, Pesisir, Simmental and Brahman) is designed as a treatment factor and meat was sampled from each animal as a group. This study was conducted by sampling the meat from the slaughtering house. Samples were stored in the refrigerator for 24 h and parameters including pH, cooking loss, water holding capacity, Warner-Bratzler shear force, water content, fat content and protein content were measured. Meat pH was defined as the ultimate pH of meat after 24 h of slaughter. Cooking loss was measured by calculating the difference in weight before and after cooking, which is carried out until the temperature inside the meat reaches 81°C. Tenderness is measured as the power required to break meat fibers using Warner-Bratzler shear force. Measurements of water, protein and fat contents of meat were carried out according to AOAC[6]. The data obtained were processed using analysis variance (ANOVA) and analyzed further using Duncan's multiple range test in the case of differing treatments.

RESULTS AND DISCUSSION

Based on the results of the study, the difference in breed significantly influenced the average pH of beef (Table 1). Beef from Bali cattle has a higher pH than the other breeds. Pesisir cattle and Simmental cross (PS) showed no significant differences, while the lowest pH was found in Brahman Cross (BC). Animal handling prior to slaughtering influences stress levels that can affect the final pH of the meat[2]. The pH changes also occur after the death of the animal, through the handling of meat after slaughter[7].

In this study, the breed of cattle affected the cooking loss of the longissimus dorsi muscle. Simmental cross meat had the highest cooking loss compared to the others, causing loss of nutrients. The lowest cooking loss was found in the meat of Pesisir cattle. The range of meat cooking loss obtained in this study was 25.48-34.04%. In general, cooking losses ranged from 15-40%[2].

Many factors can affect the value of cooking loss. Soeparno[2] stated that the meat was affected by the length of muscle fibers, the longer the muscle fibers, the lower the cooking loss. The meat of Pesisir cattle showed low cooking loss and is therefore, assumed to have longer muscle fibers,

Table 1: Average of pH, cooking loss and tenderness of different breeds of cattle

Breeds of cattle	pH	Cooking loss (%)	Warner-Bratzler shear force (kg cm^{-2})
Bali	5.88^{a}	29.92^{b}	5.84^{b}
Pesisir	5.71^{ab}	25.48^{c}	6.48^{a}
Simmental Cross (SC)	5.70^{ab}	34.04^{a}	5.36^{c}
Brahman Cross (BC)	5.52^{b}	29.64^{b}	6.24^{ab}

while the cooking loss of meat from Bali, Simmental cross and Brahman cross cattle were high and indicative of shorter muscle fibers. Changes in the structure of the meat for intramuscular fat increases the water holding capacity. In general, the higher the cooking temperature, the greater the fluid loss in meat up to a constant level[2].

The average Warner-Bratzler shear force levels of meat from all breeds studied (Table 1) were similar, ranging from 5-6.5 (kg cm^{-2}), with the highest Warner-Bratzler shear force found in the meat of Pesisir cattle and the lowest in meat of the Simmental cross.

The longissimus dorsi muscle has a smaller myofibrial structure and the level of tenderness is lower than in the semi membranous muscle. However, in this study it was found that the level of tenderness is also influenced by the breed of cattle, with the meat of Pesisir cattle having a higher level of Warner-Bratzler shear force compared to Bali, Brahman cross and Simmental cross cattle. These findings show that breed influences muscle structure. Meat with a small muscle structure is tenderer than meat from large type cattle[1]. According to Obuz *et al.*[8], the value of meat tenderness is influenced by the factors such as the handling of livestock prior to slaughter, the connective tissue present in the flesh, the fiber and fat-related muscle groups and the breed of cattle.

The highest water holding capacity was found in meat of the Brahman cross, while meat from Bali cattle had the lowest water holding capacity (Table 2). Water Holding Capacity (WHC) or Water Binding Capacity (WBC) is the ability of meat to bind water due to external influences, such as meat cutting, heating, grinding and pressure. Water binding capacity greatly affects the appearance and properties of the meat when cooked and chewed[2].

On average, the water holding capacity of meat from Bali and Pesisir cattle were not significantly different (Table 2). The decline in water holding capacity can be detected by the exudation of fluid, called weep, on raw meat that has not been frozen, drips from thawed meat that was previously frozen or wrinkles on cooked meat, which are due to the exudation of fluid from fatty meats[2].

Analysis of variance results showed that treatment significantly influenced water holding capacity. Water holding capacity is also affected by refrigeration for 24 h, resulting in drip. Drip causes a loss of nutrients in meat and the water holding capacity of the muscle decreases. In addition to the factors of pH, withering and cooking or heating, the water holding capacity of meat is also affected by other factors such as species, age and muscle function[5].

The average water content of meat is shown in Table 3. Based on analysis of variance results, there are differences in meat water content among the breeds. The water content of meat after a further DMRT is shown in Table 3. Pesisir cattle have a significantly higher ($p<0.01$) water content than the other three breeds. However, no significant difference was found between the Bali, Brahman cross and Simmental cross cattle. This may be due to feed source and the extensive rearing of Pesisir cattle that generally cause this breed to move more than others. Adrial[9] stated that Pesisir cattle is one of the Indonesian local cattle commonly found in West Sumatera and has a potential for meat production. Although has smaller body than other local cattle, Pesisir cattle have high adaptation to low quality feed, extensive traditional raising system and resistance to parasites. According to Soeparno[2], the water content of the meat is affected by the type of animal, age, sex, feed and the locations and functions of the muscle. Young cattle have higher water levels because the formation of protein and fat in the meat has not fully developed. The proportion of dry matter increases with age.

Table 2: Percentage of free water content and water holding capacity

Breeds of cattle	Free water content (%)	Water holding capacity (%)
Bali	46.55	23.49^{b}
Pesisir	43.57	24.53^{b}
Simmental Cross (SC)	48.66	27.05^{ab}
Brahman Cross (BC)	47.43	33.33^{a}

Table 3: Average of water content, protein and fat contents of longissimus dorsi muscles

Breeds of cattle	Water content (%)	Protein content (%)	Fat content (%)
Bali cattle	74.06^{a}	17.72^{b}	4.93^{c}
Pesisir cattle	67.76^{b}	19.78^{a}	5.11^{b}
Simmental Cross (SC) cattle	74.65^{a}	14.64^{d}	6.02^{a}
Brahman Cross (BC) cattle	73.27^{a}	16.24^{c}	5.86^{ab}

The average value of the water content of meat, as shown in Table 3, ranged from 67.76-74.65%, indicative of normal water content because the water content does not exceed the threshold of normal water content for fresh meat. This is in accordance with the findings of a study conducted by Soeparno[2], which stated that the water content of the meat ranges from 65-80%. According to Lawrie[1], young animals have a higher water content than older animals; increasing age results in increasing intramuscular fat deposition in meat, followed by a decreased the water content. The water content of meat often has a significant negative correlation with the fat content of meat[2].

The average protein content of meat obtained in this study for each breed is shown in Table 3. Based on the analysis of variance results, there are differences among the meat protein contents from each breed. Comparisons of meat protein content after further analysis using the Duncan test

are shown in Table 3 and indicate that breed has a highly significant effect ($p<0.01$) on protein content. Soeparno[2] stated that the factors affecting the quality of meat are species specific and include genetics, breed, gender, age, feeding and stress. Lawrie[1] reported that differences in body composition associated with increasing age. Variations in the chemical composition of meat (protein) can be caused by differences in growth, breed, age, location and feed[10].

The protein content of beef is influenced by factors before and during slaughtering. Soeparno[2] stated that the biochemical and biophysical changes in the conversion of muscle to meat begins at the time of slaughter. Factors affecting livestock conditions before slaughter also affect the conversion rate of muscle into meat as well as the quality of the meat produced. According to Lawrie[1], meat protein plays a role in binding meat broth. The high protein content of meat causes increased water holding ability, lowering the free water content and vice versa.

Based on the analysis of variance results, there is a difference between the fat content of meat among breeds (Table 3). There are also variations in the fat content of meat within each breed. Meat from Simmental cross and Brahman cross cattle has a higher fat content than meat from Pesisir and Bali cattle. This shows that marbling will affect the fat content of meat. According to Soeparno[2], the fat content of meat varies and can be influenced by breed, age, species, location and feed. Additionally, Lawrie[1] stated that the fat content of meat ranges from 5-24%.

CONCLUSION

The breed of cattle effects meat quality (pH, tenderness, cooking loss, water holding capacity, water content, protein and fat contents) of the longissimus dorsi muscle.

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