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Physical Meat Quality of Red Brahman Crossbred and Droughtmaster Cattle at Different Sexs and Ages

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ABSTRACT

The physical meat quality is reflected by meat characteristics and references for consumers to choose good quality beef. Several factors that affect the meat quality are interacting genetic and environmental factors during maintenance until post-slaughter. The research was conducted to evaluate the physical meat quality with the breeds factor (Red Brahman Crossbred and Droughtmaster), sexs (steer and heifer), and ages (PI_0, PI_2, and PI_4). The research materials were 120 samples of Longissimus dorsi ribs 12th from AM FARM abattoir and tested physical meat quality on QC Laboratory of KASA Company. The data were analyzed by ANOVA and the Least Significant Difference if there were any significant. The variables observed were pH, meat color, WHC, cooking loss, and tenderness. The results showed that breed factors have no significant difference in physical meat quality. The factor of sexs nested to breeds has very significance ($p<0,01$) on physical meat quality except for pH and tenderness there weren't significant differences. The factor of ages nested to sexs nested to breeds has very significant ($p<0,01$) on physical meat quality except for that pH. The conclusion is that the evaluation of physical meat quality can be predicted by the relationships of breed, sex, and age factors.

Keywords: Physical meat quality, breeds, sex, ages

INTRODUCTION

Beef is one of the main foods that contain a lot of protein, especially the complete essential amino acids required by the body. The increasing demand for high-quality beef has been a result of an increase in the population and changes in people's nutritional knowledge of food. Data from The Directorate General of Livestock and Animal Health (Ditjen PKH, 2019), and the Agriculture Data and Information Center (PDSIP, 2019) each stated that beef production in 2019 was 504,802,000 kg and in 2020 it was 515.628.000 kg, increase in meat production by 1.06%. The increase in domestic beef production is however only able to meet the national consumption of 70-75%. The agriculture data and information center (2020) stated that the level of beef consumption in Indonesia in 2019 was 2.56 kg/capita/year with meat needs of 667,308,558 kg/year and in 2020 the consumption rate per capita was 2.31 kg/capita/ year with a meat demand of 624,162,000 kg/year, resulting in a beef deficit of 24% in 2019 and 21% in 2020. The demand for beef that is higher than local beef production is the reason for carrying out beef imports (feeder cattle and frozen meat). Law of the Republic of Indonesia No. 18 of 2012 articles 14 and 36 (2012) stated that food imports can be carried out if domestic production and national food reserves are not able to meet the national food demands. Total imports for beef are 30-40% per year in the form of frozen meat (beef at 36.39% and buffalo meat at 28.66%) and feeder cattle by 34.96% or 488,743 heads (Ginanjar, 2020; Tawaf, 2020).

The feedlot is an effort to raise livestock, especially Australian feeder cattle, such as Red Brahman Crossbred and Droughtmaster cattle at the final growth stage so that optimum livestock production is obtained through the interaction of superior genetic factors and optimum environmental factors (maintenance management in Indonesia) in a short time. Philips (2018) stated that the factors which influence the production of beef cattle (carcass and meat quality) include genetics, race, age, sex, slaughter weight, feed nutrition, and livestock stress levels. The application of animal welfare from rearing to slaughter affects meat production. Farm Animal Welfare Committee (2013) mentioned that animal welfare is a strategy to ensure the welfare of livestock that must be fulfilled in the upstream-to-downstream production management system by applying the principle of five freedoms and provisions. There is a relationship between animal welfare and production (carcass and meat quality), better animal welfare during maintenance, optimum livestock stress, and optimum carcass and meat production (AHA, 2016) and (OIE, 2019). The physical quality of meat is one of the characteristics of meat that plays an important role as a reference and decision for consumers to buy meat, especially beef. Several categories of physical quality of meat used are color, pH, tenderness, water-holding capacity, texture, level of juiciness, flavor, taste, and aroma of meat (Soeparno, 2015; Rosyidi, 2017). Based on this description, it is necessary to conduct research related to the physical quality of meat in red Brahman crossbred and Droughtmaster cattle which are influenced by factors of the nation, sex, and age as well as the maintenance management system in Indonesia with the hope that the relationship between factors and the three factors can be used as a reference for stakeholders in knowing the physical quality of beef cattle.

MATERIAL AND METHOD

Place and Time

This research was conducted on March until May 2021. Meat samplings at AM FARM abattoir, Pringsewu District, and physical meat quality tested on Quality Control Laboratory of Karunia Alam Sentosa Abadi company, Lampung Tengah District.

Material

The materials used in the study were 120 meat samples from the slaughter of cattle which are grouped by the breeds factor (Red Brahman Crossbred and Droughtmaster cattle), sex factor (steer and heifer), and age factor (PI0 = 1.5 years; PI2 = 2-2.5 years dan PI4 = 3 years), so that each group consists were 10 samples. The feed ratio was used as a complete feed of standard feedlot with compositions of corn silage, concentrates, and feed additives. The nutrition contents of complete feed are crude protein was 13-14% and metabolic energy was 10.5-11.5%. Other criteria were meat samples from Longissimus dorsi ribs 12 or 13th with chilling at 0-7℃ for 8-12 hours and already thawed on running water before testing of physical quality meat. The equipment used was the assessment of physical meat quality, a mini fridge, knives set of cutting "Tramontina", meat digital scale "PS200", pH meter digital "Tester: HI 9811 Xpiccolo Hanna, distilled water, buffer pH 4 and 7, bimetal thermometer, hardness tester "GY-4", Whatman 42 paper and millimeter block, one set of moisture test includes carper press and oven, Indonesia National Standard 3932:2008 code for meat color.

Procedure

The research procedures were meat samplings from slaughtered cattle (according to criteria of material research) were 0.25 kg on Longissimus Dorsi muscles 12 and 13th, then separated on Polyethylene (PE). The chilling process of meat samples was carried out at low temperatures of 0-7℃ for 8-12 hours, and then the samples were thawed on running water for 15-30 minutes before being tested for physical meat quality.

Variables

The variables observed in this research were pH: the assessment of pH was carried out 12 hours after the samples has chilled. Meat color: the assessment of meat color was carried out on matching meat color on Longissimus dorsi 12th and 13th with meat color of SNI 3932:2008. Water holding capacity (WHC): the assessment of WHC was a measure of the total amount of water that can be absorbed by protein in meat from the influence of external forces. Cooking loss: the assessment of cooking loss was the amount from the lost percentages of meat weight after being cooked. Tenderness; the assessment of tenderness was the tenderness level of meat after being cooked.

Data Analysis

All research data were analyzed using variance (ANOVA) with a completely randomized nested design pattern (RAL Nested Design), then continued with the least significance different (LSD) test if there was a difference in influence.

RESULT AND DISCUSSION

Based on Table 1, the breeds factor (Droughtmaster and red Brahman Crossbred), the sex factor (steer and heifer) nested to breeds, and age factors (PI_0, PI_2, PI_4) nested to sex and breeds were not significantly different (p>0.05) to the pH of meat. The value of pH 12 hours on red Brahman Crossbred and Droughtmaster cattle were almost the same and within normal limits due to good animal welfare implementation during rearing. Meat and Livestock Australia (MLA, 2011) stated that the normal pH decreased from 7 to 5.4-5.8 with a wilting time of 8-12 hours. The results of the research by Ngadiyono et al. (2014) and Ngadiyono et al. (2015) showed that the pH value of SIMPO cattle was 5.59; PO cattle were 5.61, and Brahman Cross was 573. Meat and Livestock Australia (2018) states that low stress produces high amounts of lactic acid and glycogen so that the process of bleeding, rigor mortis, and optimum meat quality. The pH 12 hours value of steer or heifer on red Brahman Crossbred cattle is almost the same as Droughtmaster because of optimum temperature. Soeparno (2015) stated that high temperature accelerates the rate of pH decrease and vice versa because of the temperature rate on postmortem glycolysis. Kuswati and Susilawati (2016) stated that the rate of decrease in meat pH is influenced by intrinsic factors (species, muscle glycogen, enzymes) and extrinsic factors (temperature, feed, stress, cutting method, and post-cut handling).

The color of the meat is one of the parameters that determine the consumer's decision to buy beef, which is a bright red color. Assessment of meat color according to SNI 3932:2008, namely bright red color (score 1-5), slightly dark red color (score 6-7), and dark red color (score 8-9). Based on Table 1, the breeds factor (red Brahman Crossbred and Droughtmaster) was not significantly different (p>0.05), but the sex factor (steer and heifer) nested to breeds, and ages (PI_0, PI_2, PI_4) nested to sex and breeds were very significant (p<0.01) on meat color. The meat color of red Brahman Crossbred and Droughtmaster cattle was almost the same (bright red and slightly dark) due to good animal welfare application, low stress, optimum temperature, and optimum sample handling. Suryani et al. (2014) stated that the meat color on steer red Brahman Crossbred cattle were 7, and Kuswati et al. (2014) stated that the color of steer meat was 5.2 and heifer meat was 5.6. The meat color on steer Droughtmaster was more optimum than heifer red Brahman Crossbred due to differences in hormones and sex. Soeparno (2015) stated that the steer produces red meat color due to low movement (low testosterone), so oxymyoglobin levels are high (bright red color) compared to the heifer. Meat color score PI_0 (steer (BXM), PI_0 (heifer (BXM), and PI_0 (steer(DM) is more optimum compared to PI_4 (heifer(BXM), PI_4 (heifer(DM) because the increasing age of livestock causes the color of the meat tends to be darker. Several factors that affect meat color are factors before slaughtering (species, muscle type, feed, handling, stress, and cutting method) and factors after slaughtering (handling, storage, and packaging) (Toldra, 2017).

Water holding capacity (WHC) by meat protein is the ability of meat to bind, retain or absorb water in response to the influence of external forces (Soeparno, 2015). Based on Table 1, the breeds factor (red Brahman Crossbred and Droughtmaster) are not significantly different, but the sex factor (steer and heifer) nested to breeds and the ages factor (PI_0, PI_2, PI_4) nested to sexs and breeds are very significant (p<0.01) on water holding capacity (WHC). WHC value on Droughtmaster cattle are more optimum than red Brahman Crossbred cattle because the value of pH meat is lower (normal range). The standard of water holding capacity is 15%-60% (Soeparno, 2015). The results of research by Diniz et al. (2016) stated that WHC of Guzholstein cattle were 32.6% and Guzonell cattle were 35.4%. Toldra (2017) stated that the pH is closer to the isoelectric value (5.0-5.1) causes normal WHC due to the balance of protein reactive groups (balanced protein levels), on the other hand the further away from the isoelectric point (<5.0-5.1) or (>5.0-5.1) increases WHC due to imbalance of protein reactive groups. WHC on heifer Droughtmaster cattle are more optimum than steer red Brahman Crossbred cattle and PI_2 on heifer red Brahman Crossbred cattle are more optimum than PI_4 on steer red Brahman Crossbred cattle because difference sexs and ages. Adhyatma et al. (2017) stated that the WHC value of steer red Brahman Crossbred cattle were 30.04%. Suwignyo et al. (2010) that ACC cattle ages on 1.5-2 years had WHC value of 50.8%. Wahyuni et al. (2018) stated that the WHC of steer Brahman Cross cattle aged 2.5-3 years were 42.70%. Soeparno (2015) stated that heifers produced higher WHC value because the amount of fat deposition is more optimum than steers, while old cattle produce higher intramuscular fat deposition and lower muscle growth compared to young cattle.

Table 1. Averages of physical meat quality from red Brahman Crossbred and Droughtmaster, with *steer* and *heifer* on ages of PI_0, PI_2, and PI_4.

pH meat of 12 hours				
Breeds	Red Brahman Crossbred		*Droughtmaster*	
Averages	5.75 ± 0.09		5.73 ± 0.10	
Ages	Steer	Heifer	Steer	Heifer
PI_0	5.77 ± 0.09	5.72 ± 0.10	5.76 ± 0.10	5.73 ± 0.11
PI_2	5.75 ± 0.08	5.72 ± 0.09	5.72 ± 0.12	5.72 ± 0.08
PI_4	5.76 ± 0.11	5.76 ± 0.09	5.72 ± 0.08	5.72 ± 0.12
Averages	5.76 ± 0.09	5.73 ± 0.09	5.73 ± 0.10	5.73 ± 0.10
Meat color (SNI 3932. 2008)				
Breeds	Red Brahman Crossbred		*Droughtmaster*	
Averages	5.75 ± 0.82		5.72 ± 0.83	
Ages	Steer	Heifer	Steer	Heifer
PI_0	4.80 ± 0.42 ^{a}	4.90 ± 0.32 ^{a}	4.80 ± 0.42 ^{a}	4.80 ± 0.42 ^{a}
PI_2	5.80 ± 0.42 ^{b}	5.90 ± 0.32 ^{b}	5.80 ± 0.42 ^{b}	5.90 ± 0.32 ^{b}
PI_4	6.30 ± 0.48 ^{c}	6.80 ± 0.42 ^{d}	6.20 ± 0.42 ^{c}	6.80 ± 0.42 ^{d}
Averages	5.63 ± 0.76 ^{w}	5.87 ± 0.86 ^{w}	5.60 ± 0.72 ^{w}	5.83 ± 0.91 ^{w}
Water holding capacity (%)				
Breeds	Red Brahman Crossbred		*Droughtmaster*	
Averages	47.49 ± 2.77		48.28 ± 1.98	
Ages	Steer	Heifer	Steer	Heifer
PI_0	47.91 ± 2.44 ^{cd}	48.11 ± 2.16 ^{cde}	46.90 ± 0.99 ^{bc}	47.73 ± 1.72 ^{cd}
PI_2	45.66 ± 2.10 ^{ab}	49.88 ± 1.02 ^{f}	49.09 ± 1.56 ^{def}	49.86 ± 0.78 ^{f}
PI_4	44.45 ± 3.11 ^{a}	48.93 ± 1.14 ^{def}	46.58 ± 2.54 ^{bc}	49.50 ± 1.19 ^{ef}
Averages	46.00 ± 2.89 ^{w}	48.98 ± 1.65 ^{x}	47.53 ± 2.08 ^{x}	49.03 ± 1.57 ^{x}
Cooking loss (%)				
Breeds	Red Brahman Crossbred		*Droughtmaster*	
Averages	36.81 ± 1.28		37.06 ± 1.93	
Ages	Steer	Heifer	Steer	Heifer
PI_0	36.22 ± 1.05 ^{b}	36.84 ± 1.24 ^{b}	38.40 ± 1.29 ^{d}	39.16 ± 1.48 ^{d}
PI_2	37.11 ± 1.39 ^{c}	36.56 ± 1.16 ^{b}	35.99 ± 1.29 ^{b}	37.20 ± 1.10 ^{c}
PI_4	37.30 ± 1.41 ^{c}	36.79 ± 1.41 ^{b}	36.92 ± 1.28 ^{b}	34.67± 1.22 ^{a}
Averages	36.88 ± 1.34	36.73 ± 1.24	37.10 ± 1.60	37.01 ± 2.24
Tenderness (kg/cm^2)				
Breeds	Red Brahman Crossbred		*Droughtmaster*	
Averages	6.92 ± 0.42		6.90 ± 0.48	
Ages	Steer	Heifer	Steer	Heifer
PI_0	6.58 ± 0.24 ^{b}	6.53 ± 0.26 ^{b}	6.54 ± 0.23 ^{b}	6.36 ± 0.25 ^{a}
PI_2	7.10 ± 0.24 ^{c}	6.72 ± 0.26 ^{b}	7.20 ± 0.27 ^{c}	6.66 ± 0.23 ^{b}
PI_4	7.53 ± 0.24 ^{d}	7.06 ± 0.23 ^{c}	7.57 ± 0.26 ^{e}	7.05± 0.26 ^{c}
Averages	7.07 ± 0.46 ^{x}	6.77 ± 0.33 ^{w}	7.10 ± 0.50 ^{x}	6.69 ± 0.37 ^{w}

Note: * Different supersciprts at the same row indicated signifiCant differences ($p<0.01$), PI_0 = Permanent incisors 0 (< 1.5 years), PI_0 = Permanent incisors 2 (2-2.5 years), PI_4 = Permanent incisors 4 (3 years)

Cooking loss is an indicator of the physical meat quality from the weight percentage of meat lost due to cooking meat juiciness, temperature, and heating time (Soeparno et al., 2017). Soeparno (2015) stated that cooking loss varies by 15-40%. Based on Table 1, the breeds factor (red Brahman Crossbred and Droughtmaster) and sex factor (steer and heifer) nested to breeds are not significantly different, but the ages factor (PI_0, PI_2, PI_4) nested to sex and breeds are significantly different ($p<0.01$) on cooking loss. The cooking loss value of red Brahman Crossbred cattle is more optimum than Droughtmaster cattle and heifer red Brahman Crossbred cattle are more optimum than steering Droughtmaster (normal cooking loss) because the values of pH and WHC are almost the same. Soeparno et al. (2017) stated that if the pH value is higher or lower than the isoelectric point (5.0-5.1), it lowers the WHC value and increases the cooking loss. The cooking loss value on PI_4 (heifer(DM) is more optimum than PI_0 (heifer(DM) because age differences. Suwignyo et al. (2010) stated that ACC steer cattle with the age of 1.5-2 years had a cooking loss of 36.10%. Wahyuni et al. (2018) stated that 2.5 years on steer Brahman Cross cattle had a cooking loss of 44.90%. Toldra (2017) stated that cooking loss decreases with the increasing age of cattle. Soeparno (2015) stated that it is influenced by the cross-sectional area of the muscle sarcomere, myofibril contraction status, feed, salt addition, clotting, and thawing.

Tenderness of meat as an indicator of meat quality assessment and a consumer decision parameter to buy meat. Objective test of tenderness with Warner-Bratzler has divided into several categories, they are namely very tender (<4.15 kg/cm^2), tender (4.15-5.86 kg/cm^2), slightly tender (5.86-7.56 kg/cm^2), a bit tough (7.56-9.27 kg/cm^2), tough (9.27-10.97 kg/cm^2), and very tough (>10.97 kg/cm^2) (Soeparno, 2015). Based on Table 1, the breeds factor (red Brahman Crossbred and Droughtmaster) are not significantly different, but the sexs factor (steer and heifer) nested to breeds, and the age factor (PI_0, PI_2, PI_4) nested to sexs and breeds were very significant ($p<0.01$) on the tenderness. The results of Rosyidi et al. (2010) stated that the tenderness value of PO cattle was 1.32 kg/cm^2 and SIMPO cattle was 1.01 kg/cm^2. Elzo et al. (2012) stated that the tenderness value of Bos *indicus steer (½ Angus x Brahman) were 5.64* kg/cm^2 and *Bos taurus* steer (¾ Angus x Brahman) were 5.64 kg/cm^2. Ngadiyono et al. (2014) stated that SIMPO beef tenderness was 0.55 kg/cm^2 and PO was 11.18 kg/cm^2. Ngadiyono et al. (2015) stated that tenderness of SIMPO beef was 7.18 kg/cm^2 and Brahman Cross 7.23 kg/cm^2. Tenderness value of Droughtmaster beef (*Bos taurus*) is more optimum than the red Brahman Cross (*Bos indicus*). Soeparno (2011) and Toldra (2017) stated that the genetics of breeds in the form of textures (smooth, rough) and muscle type (large, small) of breeds affect the level of tenderness with the inheritance value from parents to calves by 60% (Soeparno, 2015). The tenderness value of heifer red Brahman Crossbred cattle are more optimum than steer Droughtmaster cattle due to differences activity of steer and heifer muscles. Kuswati and Susilawati (2016) stated that the movement of steer is more active, causing muscles with high movement to have high meat fibers, coarse textures, and low fat, so that the tenderness of steer meat is lower (harder meat) compared to heifer. Different parts of the muscle affect the level of tenderness. Soeparno (2015) stated that the difference in muscle parts related to the amount of connective tissue (muscle activity) and the level of tenderness, namely the deep has muscle (Longissimus dorsi) has little movement, low connective tissue, and optimum tenderness than biceps femoris muscle. Choiria et al. (2019) stated that the tenderness of Ongole cattle with ages of 2-2.5 years were 4.77 kg/cm^2 and age of 3 years were 5.53 kg/cm^2. The tenderness value of PI_0 (heifer(DM) is more optimum than PI_4 (steer(DM) because of age differences. Soeparno (2015) stated that increasing age reduces the level of tenderness including low connective tissue (connective tissue is lower than collagen).

CONCLUSION

Red Brahman Crossbred and Droughtmaster cattle have the same and normal pH, meat color, WHC, cooking loss, and tenderness. Steers on Droughtmaster and red Brahman Crossbred are optimum for meat color and WHC with the same and normal pH and tenderness, while the heifers on Droughtmaster and red Brahman Crossbred cattle are optimum for tenderness. The optimum value of physical meat quality of cattle is PI_0 on steering red Brahman Crossbred and Droughtmaster cattle for meat color, PI_0 on heifer Droughtmaster for tenderness, PI_2 on heifer Droughtmaster for WHC, and PI_4 on Droughtmaster for cooking loss. The values of pH are the same and normal for age factors nested to sex and breeds.

CONFLICT OF INTEREST

Agus Susilo is a reviewer at JITRO (Jurnal Ilmu dan Teknologi Peternakan Tropis), but he hasn't a role in the decision-making to publishing this article. The author declares that there is no conflict of interest over financial, personal, or other relationships with certain parties regarding the material discussed in the manuscript.

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