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Characteristics Carcass of Steer and Bull of White Brahman Crossbred Cattle at Different Ages

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ABSTRACT

The objective of this study was to determine the effect of sex and age of slaughter on the carcass characteristics of white Brahman crossbred cattle in feedlot Lampung, Indonesia. A total of 126 white Brahman cattles consisting of 63 steers (21 PI0, 21 PI1, 21 PI2) and 63 bulls (21 PI0, 21 PI1, 21 PI2) were selected for this study. The slaughter was conducted using non stunning method using box mark 4. Data analysis was done using factorial completely randomized design and Duncan's continued test. The results showed that the slaughter age factor significantly ($p<0.05$) had a significant effect on slaughter weight, carcass weight, carcass percentage, meat weight, fat weight, fat percentage, bone weight, bone percentage, meat bone ratio (MBR), meat fat ratio (MFR) and rib eye area (REA). The interaction of sex and slaughtering age factors showed a significant effect ($p<0.05$) on slaughter weight, carcass weight, meat weight, meat percentage, bone percentage, and MBR. Sex and age of slaughtering had no significant effect ($p>0.05$) on the thickness of the back fat of the white Brahman crossbred cattle. It can be concluded that the factors of sex and age have an effect on the carcass characteristics of the white Brahman crossbred cattle.

Keywords: bull, carcass characteristics, white brahman crossbred, steer

INTRODUCTION

Beef is a type of animal protein source food that helps Indonesians meet their nutritional requirements. Beef demand, which has risen year after year, must be balanced against the supply of beef cattle. The need for beef in Indonesia is met from local cattle, imported cattle in the form of feeder cattle, one of which is Brahman cross. The Brahman Cross cattle is a cross of the Brahman breed from Zebu with Taurine in Australia. Brahman cross (BX) cattle are a breed of cattles resulting from crosses from 3 nations, namely Brahman (Bos Indicus) cattle with Shorthorn and Hereford (Bos taurus) cattle with a proportion of 50% blood of Brahman cattle (Bos indicus), 25% blood of Hereford cattle (Bos taurus) and 25% blood of Shorthorn cattle (Bos taurus) (Gillespie and Flanders, 2010). Carcass is an important factor in beef cattle production. Carcass composition is defined as the proportion of fat, muscle, bone, and other tissues in the carcass including tendons, ligaments, fascia, glands and large blood vessels and is generally supplied with bone (Keane, 2011). It is hoped that beef cattle can produce optimal carcass both in quantity and quality in order to meet the needs. The proportion of slaughter, especially meat and carcass, is influenced by the process of growing the cattle.

Genetic interactions that occur in cattles, including sex and age of the cattle, are several important factors that can affect the proportion of carcass produced. The growth rate and composition of livestock acquisition, namely carcass and meat quality, can be significantly influenced by differences in sex and age of livestock (Lawrie, 2017). This study discusses how the influence of sex and slaughtering age factors on the carcass characteristics of White Brahman Cross cattle.

MATERIAL AND METHOD

Location and Research

This research was conducted on January 4th-30th, 2021 at the AM Farm Pringsewu and PT KASA Lampung.

Research Material

The Brahman cross cattle used came from Australia and raised at the feedlot of PT. KASA Lampung province. The materials used were 126 white Brahman cross cattles, the cattles consisted of 2 sexes, namely 63 steers and 63 bulls, each consisting of 3 slaughter age groups, namely 21 PI0 (0-1.5 years), 21 PI1 heads. (1.5-2 years), and 21 PI2 (2-3 years). The feed given was complete feed made from cereals and silage adlibitum with 90-120 days Days on Fattening.

Research Procedure

Cattles that are ready for slaughter are then sent to the AM Farm Pringsewu Slaughterhouse for the slaughtering process. The cattle is rested for 12-24 hours before the slaughtering process is carried out. The slaughtering process is carried out using a non stunning method using a restaining box mark 4. Cattles are weighed at the end to obtain slaughter weight. Cattles are brought to the box mark 4 and then slaughtered and in accordance with the Halal standards of the Indonesian Ulema Council (MUI). Obtained carcass weight and carcass component weight (bone meat and fat), the area of the Rib Eye Area was obtained by measuring the longissimus dorsi between the 12th and 13th rib pieces and the thickness of the back fat.

Research Variables

The variables observed in this study were evaluating carcass characteristics consisting of slaughter weight, carcass weight and percentage, meat weight and percentage, fat weight and percentage, bone weight and percentage, meat bone ratio, meat fat ratio, rib eye area, and back fat.

Data Analysis

The data obtained were analyzed statistically using a completely randomized design method. Factorial patterns, namely the factor of sex, age factor and the interaction between these two factors. The resulting data were analyzed using Duncan's advanced test.

RESULT AND DISCUSSION

Slaughter weight, carcass weight, carcass percentage, carcass component weight (meat weight, meat percentage, bone weight, bone percentage, fat weight, fat percentage) are presented in Table 1.

Table 1. Slaughter weight and carcass components

Variable	Sex	Slaughter age			Average
		PI0 (<1,5 years)	PI1 (1,5-2 years)	PI2 (2-3 years)	
Slaughter Weight (kg)	Steer	480.42±36.37^{abcd}	507.61±53.44^{de}	539.61±41.41^{f}	509.22±49.96
	Bull	464.47±34.12^{a}	469.85±42.50^{ab}	479.33±29.27^{abc}	471.22±35.68
Carcass Weight (kg)	Steer	274.08±22.07^{abcd}	295.50±31.02^{e}	311.95±25.16^{e}	293.84±30.27
	Bull	266.30±19.80^{a}	270.25±26.30^{ab}	276.01±19.12^{abc}	270.86±21.99
Carcass Percentage (%)	Steer	57.04±1.20	58.22±0.93	57.79±1.02	57.68±1.15
	Bull	57.34±1.18	57.49±0.92	57.57±1.40	57.47±1.18
Meat Weight (kg)	Steer	193.77±18.38^{abc}	211.04±23.59^{de}	224.23±20.95^{e}	209.68±24.25
	Bull	191.75±17.30^{a}	192.44±19.95^{ab}	198.02±16.18^{abcd}	194.07±17.82
Meat Percentage (%)	Steer	70.63±1.29^{a}	71.38±1.18^{bcd}	71.81±1.37^{de}	71.27±1.36
	Bull	71.93±1.49^{d}	71.17±1.08^{bc}	71.69±1.36^{cde}	71.43±1.34
Bone Weight (kg)	Steer	63.75±3.70	66.58±6.50	67.24±3.93	65.86±5.04
	Bull	58.82±3.65	61.74±5.71	60.38±3.33	60.31±4.45
Bone Percentage (%)	Steer	23.33±1.3^{d}	22.57±1.14^{bcd}	21.63±1.42^{a}	22.51±1.45
	Bull	22.17±1.69^{abc}	22.88±1.21^{cde}	21.94±1.51^{ab}	22.33±1.49
Fat Weight (kg)	Steer	16.55±1.59	17.87±2.02	20.47±2.33	18.30±2.56
	Bull	15.73±1.74	16.06±1.89	17.60±2.25	16.46±2.11
Fat Percentage (%)	Steer	6.03±0.26	6.04±0.17	6.55±0.38	6.21±0.37
	Bull	5.89±0.36	5.94±0.35	6.36±0.50	6.06±0.45

Note: Different superscripts in the same column show a significant difference ($p<0.05$), PI = Permanent Incisors

Based on the data in Table 1, it was found that sex and age of slaughter had a significant effect on slaughter weight and there was an interaction between these two factors ($p<0.05$). The average slaughter weight of steer 509.22 kg is greater than bull 471.22 kg with the interaction of sex treatment and slaughtering age PI1 steer is the best treatment of slaughter weight for brahman cross cattle. This research shows that the slaughter weight of steer and bull beef increases significantly with increasing slaughtering age. The weight of adult livestock is higher than young cattle due to the fact that the body size of young cattle is not maximized and is still experiencing growth, namely the division of cells to a certain body weight which then experiences sexual maturity known as development (Zajulie et al., 2015). The difference in slaughter weight between steer and bull in this study was caused by differences in the type of feeder in the steer, namely the medium steer and the bull, namely the feeder bull. Rodriguez's (2014) research on 26-month-old brahman cross cattles resulted in a higher slaughter weight steer than steer, namely 439.1 kg steer slaughter and 437 kg bulls. The sex of livestock is one of the factors that influence the resulting production. Sex has a direct effect on body weight, bulls produce higher body weight due to male livestock hormones. In steers, there is a decrease in the hormone testosterone which results in reduced energy for reproduction and increased growth (Johnson and Beckett, 2014). The hormone testosterone is one of the androgen steroids produced by testes which plays a role in growth so that it will produce different body weights according to the body composition between the sexes of bull, steer and heifer (Lawrence, Fowler and Novakofski, 2012).

The results showed that sex and age of slaughter had a significant effect on carcass weight and there was an interaction of the two factors ($P <0.05$). Carcass weight increased along with the increasing age of slaughter with the average carcass weight of 293.84 kg steer and 270.86 kg of bull. This study produces a steer carcass weight greater than bull; this is because the difference in the slaughter weight of steer is greater than bull. The treatment of slaughtering age of PI2 was the best treatment of carcass weight and the interaction of treatment of sex and age of PI2 steer was the best treatment of carcass weight of brahman cross cattle. The composition of the carcass changes with increasing carcass weight. Old cattles have a higher proportion of muscle than young cattles (Keane, 2011). Slaughtering age has a significant effect on the percentage of carcass produced, namely the average steer 57.68% and bull 57.47%. These results are not much different from the research of Kuswati et al., 2014) that the average weight and percentage of carcass of Brahman cross cattle fed cereal-based feed on steer is 235.5 kg with a percentage of 54.1%. The results of research by Rodriguez et al. (2014) on the weight and percentage of Brahman Cross steer cattle were 223.6 kg with a percentage of 55.2% and bulls 217.3 kg with a percentage of 54.3%. The composition of livestock carcass recovery is also significantly influenced by sex differences arising from the effects of steroid hormones. Male livestock grow faster than female livestock because males are more efficient in utilizing feed. Bull cattle produce higher carcass with higher meat production and less fat than steers (O'Riordan et al., 2011). Well-nourished bull cattles are heavier and have carcass with higher slaughter power than steers. Most of the studies involving bulls and steers were carried out under favorable nutritional and environmental conditions so that bulls grew 10 - 20% faster than steers (Rodriguez et al, 2014).

The results showed that meat weight increases with age of slaughter. Sex and age of slaughtering had a significant effect on meat weight but had no significant effect on the percentage of meat produced ($p<0.05$). The best treatment of slaughtering age on PI2 to meat weight. There is an interaction between sex and age factors on meat weight and percentage with the best treatment interaction on PI2 steer to meat weight of 224.23 kg and the best treatment interaction on PI0 bull to meat percentage is 71.93%. This result is lower than the study by Kuswati et al., (2014) that the percentage of Brahman cross beef fed cereal-based feed on steer is 74.6%, 73.7% and 73.5%. Research by gang et al. (2019) on bulls crossing Simmental × Luxi F1 resulted in a meat weight of 281.70 kg. Research by Zajulie et al. (2015) it is known that the weight and percentage of Brahman cross beef, which is slaughtered at different ages PI0, PI1, PI2 are 139.87 kg (72.38%), 179.38 kg (73.77%) respectively, 50kg (73.75%). Bull cattle have several advantages over steers including feed efficiency, higher body weight gain, lower proportion of carcass and fat (O'Riordan et al., 2011). Muscle growth occurs from hypertrophic results (cell enlargement) coupled with muscle

protein until muscle mass is achieved (Lawrie, 2017). Adult phase livestock (late puberty) will produce higher meat and muscle than cattle in the early puberty phase (early puberty) and have optimum fat, so slaughtering beef cattle is recommended to be slaughtered at adult weight or late puberty (Kuswati & Susilawati, 2016). Meat consists of various types of tissue, including nervous, adipose, and connective tissue. The percentage of dading is generally 50% to 70% of the carcass weight of livestock (Hui, 2012).

Sex and age of slaughtering significantly affected bone weight ($p<0.05$) with an average steer bone weight of 65.86 kg higher than bull 60.31 kg. The age of slaughter was significantly different on the percentage of bone ($p<0.05$) with the best interaction between the two factors at the age of 21.63% PI2 steer. Research by Zajulie et al. (2015) found that the weight and percentage of Brahman cross beef bones that were slaughter at different ages PI_0, PI_1, PI_2 were 32.40 kg (17.10%), 36.62 kg (15.16%), 38,06kg (13.64%) respectively. The percentage of Brahman Cross beef bones at the age of steer slaughter is 16.00% (Kuswati, et al., 2014), the percentage of bone is 17.5% (Pesonen et al., 2012). Bone growth will continue until postpubertal when the size of the mature skeleton is reached. At a younger age and lighter body weight, bone has a higher proportion than the proportion of meat and fat compared to older age and higher weight (Lawrie, 2017). The period of livestock growth begins with a slow growth rate then rapid growth until it slows down with age (adult). Livestock growth forms a sigmoid curve, that is, age does not cause an increase in body weight, but livestock have the opportunity to grow and reach the adult phase optimally, so that increasing age affects organ growth in livestock, especially the deposition of fat, meat and bones (Philips, 2010).

Sex and age of slaughtering had a significant effect on the weight and fat percentage of white Brahman cross cattle ($p<0.05$). The weight and percentage of fat increased along with the increasing age of *slaughter* with the weight and percentage of fat steer 18.30 kg and 6.21% higher than bull 16.46 kg and 6.06%. This result is lower than the results of Kuswati et al. (2014), it is known that the percentage of fat slaughter t at different ages PI_0, PI_1, PI_2 is 17.52 kg (9.13%), 23.85 kg (respectively, 9.79%), 31.58 kg (11.24%) (Zajulie et al., 2015). The weight and percentage of fat can be affected by the content of the feed given. The energy content in feed affects the proportion of carcass and fat produced. Provision of balanced nutrition will produce optimal carcass. Carcasses derived from livestock fed high energy feed contain more fat than those given low energy (Soeparno, 2015). Growth differences also occur in bull, steer and heifer cattle, which indicate genetic and hormonal differences in the rate of fattening or an increase in the proportion of fat relative to muscle and bone. Sex affects tissue growth and carcass composition due to the presence of sex hormones (steroid hormones). Bulls will have faster growth than female cattles because of the androgen hormones (Bures and Barton, 2012). Increasing age and slaughter weight resulted in a decrease in the proportion of muscle and bone while the proportion of fat increased. Protein absorption decreases when it reaches adulthood, resulting in additional fat in the body (Lawrie, 2017). After the age of adult cattle there is accumulation of fat in several parts of the body, under the skin and around the organs in the development of body fat deposition, including intermuscular, perineal, kidney, subcutaneous and omental fat. Bull sex cattles have a lower proportion of fat compared to steers and heifers (Keane, 2011).

Table 2. Meat, fat, and bone ratio

Variable	Sex	Slaughter age			Average
		PI0 (<1,5 years)	PI1 (1,5-2 year)	PI2 (2-3 years)	
Meat Bone Ratio (%)	Steer	3.04 ± 0.24^{a}	3.17 ± 0.21^{bcd}	3.33 ± 0.26^{de}	3.18±0.27
	Bull	3.26 ± 0.32^{cde}	3.11 ± 0.19^{abc}	3.28 ± 0.27^{de}	3.22±0.27
Meat Fat Ratio (%)	Steer	11.71±0.54	11.82±0.45	10.99±0.71	11.51±0.68
	Bull	12.22±0.65	12.01±0.74	11.32±0.87	11.85±0.84
Rib Eye Area (REA)	Steer	91.0±1.35	88.4±1.66	84.3±1.27	87.9±1.44
(cm^2)	Bull	90.0±1.44	80.9±1.37	80.1±1.33	83.6±1.43
Back Fat (mm)	Steer	0.97±0.23	1.02±0.28	1.01±0.22	1.00±0.24
	Bull	0.92±0.23	0.97±0.17	0.97±0.17	0.93±0.22

Note: Different superscripts in the same column show a significant difference ($p<0.05$)

The results showed that the slaughter age had a significant effect on the meat bone ratio with the best slaughter age at PI1 ($p<0.05$). There is an interaction between sex and age, namely the PI0 steer, which is 3.04%, is the best treatment for the value of the meat bone ratio. Research by Carvalho et al. (2010) shows that the meat bone ratio of PO bulls is 4.39% and Kuswati et al. (2014) shows the value of the meat bone ratio of Brahman cross cattle at different fattening times (1,2 and 2,5 months), namely steer 4.3%, 5.1% and 4.4% and the yield of the meat to bone ratio is 5.75% (Geng et al., 2019). A higher consumption of protein and energy will result in a faster growth rate. Increasing body weight has an effect on decreasing the proportion of meat and bones in carcass, while the proportion of fat increases. At the age of about 2-3 years of fattening the bone growth rate has started to decline, and the next process is to increase the weight of meat and fat. The increase in meat weight was dominated by the increase in intramuscular fat. The percentage of fat has a negative correlation with the percentage of bone and meat but has a positive correlation with the meat-bone ratio (Carvalho et al., 2010). Sex and age of slaughter significantly affected the value of the meat fat ratio ($p<0.05$) with an average steer of 11.51% and bull of 11.85%. Kuswati et al. (2014) research on Meat Fat Ratio in Brahman cross cattle, each value consists of a steer of 4.6 ± 0.4 and a heifer of 4.6 ± 0.6. The meat fat ratio is important to take into account because it is related to the level of muscle in the carcass and the value of the meat (Soeparno, 2011). An increase in fat score reflects the amount of subcutaneous fat in carcass, generally accompanied by an increase in marbling fat. This in turn can affect the characteristics of the carcass and the components of the carcass (Sami et al., 2004).

Based on the data in table 2. It is known that slaughtering age has a significant effect on the value of the rib eye area of the white Brahman cross cattle ($p<0.05$). The area of the rib eye area, which shows that the steer of 87.9 cm^2resulted in a rib eye area value that was higher than that of the bull, was 83.6 cm2. This result is greater than the research of Rodriguez et al. (2014), namely the rib eye area of Brahman cross steer cattle 62.3 $cm^2$and bulls 62.4 cm^2. Research by Highfill et al. (2012) found that the average rib eye area value of cattle in different breeds, namely Bos taurus (Hereford X Angus) was 71.7 cm2 and Bos indicus cattle (Brahman X Sahiwal) was 65.3 cm2. and in another study of 72.36 cm^2 (Geng et al., 2019) Rib Eyes Area is a productive trait that has high heritability (h^2) or inheritance of 0.70 or 70% (Soeparno, 2015). Muscle size and fat thickness of M. longissimus dorsi correlated with carcass conformation, carcass meat and fat proportion respectively (Conroy et al., 2010). The carcass conformation score and the area of the longissimus dorsi muscle increased in parallel with the increase in slaughter age at higher ages (Sami et al., 2004). The production of carcass in the steer is influenced by the decrease in the hormone testosterone due to castration. Castration is carried out to suppress the production of the hormone testosterone, which has the effect of increasing carcass fat and meat in certain parts such as the 12th rib, in Bos indicus there is a lower feed efficiency compared to non-castratated cattle, reduces livestock temperature and makes handling easier (Chantler, 2020).

The study showed that sex and age of slaughter had no significant effect on the thickness of the back fat of the white Brahman cross cattle ($p> 0.05$). The average value of back fat thickness in this study on steer was 1.00 mm and bull was 0.93 mm. Some research results on back fat thickness in *brahman* cross steer cattle 0.23 cm and bull 0.23 cm (Rodriguez et al., 2014), Mazzucco et al. (2016) research on back fat thickness in Angus cattle 6.2 mm, Hereford 5.6 mm and Carvalho et al. (2018) obtained the thick back fat value of Angus cattle 1.49±0.41 cm. The thickness of the back fat in Simmetal cross cattle is 0.80 cm (Geng et al., 2019). The feed factor can affect the thickness of the back fat. Cattles that are fed with higher energy produce a greater value of back fat thickness than feed with lower energy. The nutritional content in feed has an influence on the proportion of carcasses, especially on fat, the higher the ration energy given to livestock, the higher the subcutaneous fat so that the proportion of fat increases and the proportion of meat produced decreases (Soeparno, 2015). The thickness of the back fat can be influenced by national factors which are productive traits that have heritability (h^2) or inheritance from parent to child by 38% which is influenced by feed and age of slaughtering livestock (Lawrie, 2017).

CONCLUSION

The results showed that the slaughter age factor significantly had a significant effect on slaughter weight, carcass weight, carcass percentage, meat weight, fat weight, fat percentage, bone weight, bone percentage, meat bone ratio (MBR), meat fat ratio and rib eye area. The interaction of sex and slaughtering age factors showed a significant effect on slaughter weight, carcass weight, meat weight, meat percentage, bone percentage, and MBR. The factors of sex and age have an effect on the carcass characteristics of the white Brahman crossbred cattle.

CONFLICT OF INTEREST

There is no financial, personal, and organizational conflict of interest related to the material discussed in this article.

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REFERENCES

Bures & L. Bartoň. 2012. Growth performance, carcass traits and meat quality of bulls and heifers slaughtered at different ages. Czech Journal Animal Science 57:34-43.

Carvalho, M.C., Soeparno, & N. Ngadiyono. 2010. Pertumbuhan dan Produksi Karkas Sapi Peranakan Ongole dan Simmental Peranakan Ongole Jantan yang Dipelihara Secara Feedlot. Buletin Petrenakan 34(1):38-46. [Indonesia]

Carvalho, V.V. & B.S. Stephen. 2018. Slip points of subcutaneous adipose tissue lipids do not predict beef marbling score or percent intramuscular lipid. Journal Meat Science 139:201-206

Chantler, S.A., F. Hoeb, J.A. Jacksonc, R.O. Rocad, J.E. Stegnerc, V. Kingc, R. Howarda, E. Lopeza, & J. Walkera. 2013. Effects on performance and carcass and meat quality attributes following immuno castration with the gonadotropin releasing factor vaccine boprivaor surgical castration ofbos indicus bulls raised on pasture In Brazil. Meat Science 95:78-84.

Conroy, S., M. J. Drennan, D. A Kenny, & M. McGee. 2010 The relationship of various muscular and skeletal scores and ultrasound measurements in the live animal, and carcass classification scores with carcass composition and value of bulls. Livestock Science 127:11-21.

Geng, C.Y., Q.X. Meng, & M. Zhang. 2019. Correlations between circulating ghrelin concentrations and growth performance, carcass traits, meat quality indices in finishing bulls fed high-concentrate diets. IOP Conference Series: Earth and Environmental Science 346;012088. DOI: 10.1088/1755-1315/346/1/012088

Gillespie, J.R., & F.B. Flanders. 2010. Modern Livestock and Poultry Production 8th Edition. Delmar. USA.

Hui, Y. 2012. Handbook of Meat and Meat Processing. CRC Press. Fort Lauderdale.

Johnson, B. & J. Beckett. 2014. Application of growth enhancing compounds in modern beef production: executive summary. American Meat Association Reference.

Keane, M.G. 2011. Ranking of sire breeds and beef cross breeding of dairy and beef cows. Teagasc. Grange Beef Research Centre. Occasional Series No. 9.

Kuswati, Kusmartono, T. Susilawati, D. Rosyidi, & A. Agus. 2014. Carcass characteristics of Brahman Cross breed cattle in Indonesian feedlot. IOSR Journal of Agriculture and Veterinary Science 7(4):19-24.

Lawrence, L.J., V.R. Fowler, & J.E. Novakofski. 2012. Growth of Farm Animals. 3rd Edition: Book Review. Agricultura Tropica Et Subtropica 45(4):217-218

Lawries, R.A. 2017. Lawrie's Meat Science. Eighth Edition. Wood Head Publishing. United Kingdom.

Majelis Ulama Indonesia. 2012. Pedoman Pemenuhan Kriteria Sistem Jaminan Halal di Rumah Potong Hewan (HAS 23103). LPPOM MUI. Jakarta. [Indonesia]

O'Riordan, E.G., P. Crosson, & M. McGee. 2011. Finishing Male Cattle From The Beef Suckler Herd. Irish Grassland Association Journal 45:131-146.

Phillips, C.J.C. 2010. Principles of Cattle Production, 2nd edition. Cambridge University Press. Cambridge.

Rodriguez, J., J. Unruh, M. Villarreal, O. Murillo, S. Rojas, J. Camacho, J. Jaeger, & C. Reinhardt. 2014. Carcass and Meat Quality characteristics of Brahman Cross Bulls and steers finished on tropical pastures in Costa Rica. Meat Science 96:1340-1344

Soeparno. 2015. Ilmu dan Teknologi Daging: Edisi Kedua. Cetakan Keenam. Gadjah Mada University Press.Yogyakarta. [Indonesia]

Zajulie, I.M., M. Nasich, T. Susilawati, & Kuswati. 2015. Distribusi komponen karkas sapi Brahman Cross (BX) hasil penggemukan pada umur pemotongan yang berbeda. Jurnal Ilmu-Ilmu Peternakan 25: 24-34. [Indonesia]