

## Prediction of meat quality in Bali cattle using ultrasound imaging

Jakaria<sup>1</sup>, H. Khasanah<sup>1</sup>, R. Priyanto<sup>1</sup>, M. Baihaqi<sup>1</sup> and M. F. Ulum<sup>2</sup>

<sup>1</sup>Faculty of Animal Science, Bogor Agricultural University,  
Jl. Agatis, Darmaga Campus, Bogor 16680 - Indonesia

<sup>2</sup>Faculty of Veterinary Medicine, Bogor Agricultural University,  
Jl. Agatis, Darmaga Campus, Bogor 16680 - Indonesia  
Corresponding E-mail: jakaria\_karman@yahoo.co.id

Received October 23, 2016; Accepted March 17, 2017

### ABSTRAK

Penelitian ini bertujuan menduga karakteristik kualitas karkas sapi Bali menggunakan citra ultrasonografi. Sebanyak 81 ekor sapi Bali yang terdiri atas jantan (62 ekor) dan betina (19 ekor) dengan variasi umur antara 1 sampai 6 tahun dikoleksi data bobot badan dan kualitas karkasnya. Kualitas karkas yang diamati meliputi tebal lemak punggung (BF), tebal *longissimus dorsi* (LD), tebal lemak *rump* (RF), tebal *rump* (RT), skor *marbling* (MS) dan persentase lemak intramuskuler (PIF) diukur menggunakan ultrasonografi. Pengambilan citra ultrasonografi dilakukan pada frekuensi 4.5-6,5 MHz dan kedalaman 8.8-13.0 cm. Pengukuran BF, LD, MS dan PIF dilakukan diatas rusuk ke 12-13, sedangkan pengukuran RT dan RF diantara tulang *ischium* dan *illium*. Penentuan nilai MS menggunakan standar *Aus-Meat*, sedangkan PIF dihitung berdasarkan Deaton dan Rouse (2006). Data bobot badan dan kualitas karkas dianalisis secara deskriptif dan korelasi. Hasil analisis menunjukkan performa bobot badan dan kualitas karkas berbeda antara sapi jantan dan betina, demikian juga pengaruh umur menunjukkan perbedaan sifat bobot badan dan kualitas karkas. Hasil analisis korelasi antar sifat (bobot badan dan kualitas karkas) menunjukkan korelasi yang erat dan positif ( $P < 0.05$ ) dengan koefisien korelasi 0.291-0.938. Berdasarkan hasil yang diperoleh bahwa citra ultrasonografi dapat digunakan untuk menduga karakteristik kualitas karkas sapi Bali.

*Kata-kata kunci: sapi Bali, citra ultrasonografi, kualitas karkas*

### ABSTRACT

The objective of this study were to predict carcass quality characteristics in Bali cattle using ultrasound imagery. The Number of samples were 81 heads of Bali cattle consist of bulls (62 heads) and cows (19 heads) with various age ranging from 1 to 6 years were collected their body weight and carcass qualities including backfat thickness (BF), longissimus dorsi thickness (LD), rump fat thickness (RF), rump thickness (RT), marbling score (MS) and the percentage of intramuscular fat (PIF). Those were estimated using ultrasound performed on 4.5-6,5 MHz frequency with depth of 8.8-13 cm. The BF, LD, MS and PIF measurement were applied on 12<sup>th</sup>-13<sup>th</sup> ribs, while the RT and RF measurement were conducted between *ischium* and *illium*. MS determination was calculated using *Aus-Meat* standard, while PIF was analysis based on Deaton and Rouse (2000). Body weight and carcass quality among traits were analyzed using descriptive and correlation procedures. The results showed that performance of body weight and carcass quality differs between Bali bulls and Bali cows, as well as among the age variations. Correlation analyses among traits (body weight and carcass quality) showed strong positive correlation ( $P < 0.05$ ) ranging from 0.291 to 0.938. In conclusion, ultrasound imaging method could be used to estimate carcass quality characteristics in Bali cattle.

*Key words: Bali cattle, ultrasound imaging, carcass quality*

## INTRODUCTION

A famous origin cattle from Indonesia is Bali cattle (*Bos javanicus*) used as beef cattle and has potential for meet producer to fulfill the required meet in Indonesia. This cattle also suitable risen by small farmer in Indonesia (Martoyo, 2012). Although Bali cattle body frame is small, their carcass percentage was high about 52.72-57.6% (Hafid and Rugayah, 2009). This was higher than other Indonesia origin and local breed such as Peranakan Ongole (Ongole Grade) about 49,40%, SimPo (Crossbred of Simmental-Ongole Grade) about 51,18% (Carvalho *et al.*, 2010), Madura cattle about 47% (Wiyatna, 2007) and Sumba-Ongole (SO) cattle about 55.25% (Yantika *et al.*, 2016). USDA (2014) explained that beef carcass grade yield is influenced by layers of fat on rib, loin, rump, clod, flank, cod/udder and ribeye area.

In the breeding context, meat quality characteristics has highly an economic traits and should be predicted, because selected superior cattle must not be slaughtered and should be kept to improve genetics quality and productivity. Ultrasound imaging has been widely used to observe intramuscular fat of beef cattle both quantitatively and qualitatively (Kim *et al.*, 1998). Furthermore, ultrasound imaging can be used for determining meat and fat characteristic of live animal, particularly for intramuscular fat percentage and marbling score (Gupta *et al.*, 2013). Prediction of longissimus muscle area, subcutaneous fat thickness and rump fat thickness can be done accurately using ultrasound imaging with coefficient of determination between ultrasound imaging data and real data after slaughter about 0.98 or correlation coefficient value about 0.96 (Melendez and Marchello, 2014). This method is considered as a simple, viable, effective, fast and accurate to determine carcass composition of beef cattle (Lambe *et al.*, 2010). The ultrasound usage has followed different strategies and objective in beef cattle, including to record economic traits of carcass, make regular recording of interesting parameters on live cattle and predict optimal slaughter age by estimating carcass properties when the cattle still lives (Lambe *et al.*, 2010; Brethour, 2000). Ultrasound imaging would be very important, since the limitation data of Bali cattle carcass quality. Previous study showed that ultrasound imaging has been used widely on beef cattle (Greiner *et al.*, 2003; May *et al.*, 2000). The correlation among valuable traits also important

related to selection objective to obtain increasing of more than one trait.

The aimed of this study was to predict carcass quality characteristics and relationship among body weight and carcass qualities in Bali cattle using ultrasound imaging.

## MATERIALS AND METHODS

Our research using Bali cattle from Bali cattle breeding center (BPTU-HPT Denpasar) and PT Karya Anugrah Rumpin (KAR) as much as 81 heads consisted of 62 males and 19 females with various age ranging from 1-6 years were collected (Table 1). The cattle from BPTU-HPT were risen in one paddock and treated with the same feeding management. Cattle were fed with feed concentrate (1% of body weight) and forage (10% of body weight), while samples from PT KAR were risen intensively in coloni cage. The observed variables were body weight (BW) and carcass quality including backfat thickness (BF), longissimus dorsi thickness (LD), rump fat thickness (RF), rump thickness (RT), marbling score (MS) and the percentage of intramuscular fat (PIF). Carcass quality attributes were estimated using ultrasound linear transducer with frequency 4.5 to 6.5 MHz with a depth of 8.8 to 13 cm. Application of ultrasound on BF, LD, MS and PIF followed Ulum *et al.*, (2014) on 12-13 ribs, while the measurement of thickness of rump and rump fat according to Silva *et al.* (2012) performed between *ischium* and *illium* as presented in Figure 1. For better image, application of ultrasound conducted on the shearing skin hair and using ultrasound gel as coupling agent to facilitate contact surface between probe and skin. Determination of marbling score (MS) was calculated according to the Aus-Meat standard (<http://www.wagyu.org.au/marbling/>), while the PIF was analysis based on Deaton and Rouse (2000). All of ultrasound images data were stored in JPEG format then analyzed using Image-J software. Body weight and carcass quality among traits were analyzed using descriptive procedure and the correlation among traits were analyzed using spearman correlation followed procedure of SAS (2009).

## RESULT AND DISCUSSION

Ultrasound imaging result of Bali cattle is presented in Figure 2. Tables 2 and Table 3 showed the descriptive analysis of the traits. This

result showed that body weight and carcass quality influenced by sex, age and environment. According to Jazulie *et al.* (2015), age has significant influence to slaughtered weight, carcass weight, carcass componen and fatty. Age also influences componens and weight of carcass, meat percentage and bones (Irshad *et al.*, 2012). Thus, the older the animal, the greater the proportion of fat in the carcass and instead will be a small proportion of meat and bone. The subcutaneous fat in one year of Bali cattle was

lower than the older both in female and male.

Analysis of ultrasound image showed that backfat thickness (BF) estimation of Bali cattle aged one year was  $1.59 \pm 0.40$  mm and then a sharp increase ensue to more than one years cattle, the BF about  $5.39 \pm 0.54$  mm. The BF of three years old Bali bull only  $1.59 \pm 0.51$  mm lower than Lee *et al.* (2014) that reported ultrasound backfat thickness of three years old Hanwoo cattle was  $5.10 \pm 2.60$  mm with an area of rib about  $51.20 \pm 7.7$  cm<sup>2</sup>. Khasanah *et al.*

Table 1. The Samples Number According to Sex and Age

Sex	Age (year)	Number	Collected from
Female	1	13	BPTU-HPT Bali Province
	3	6	PT KAR
Male	1	18	BPTU-HPT Bali Province
	3	16	BPTU-HPT Bali Province
	4	23	BPTU-HPT Bali Province
	6	5	BPTU-HPT Bali Province

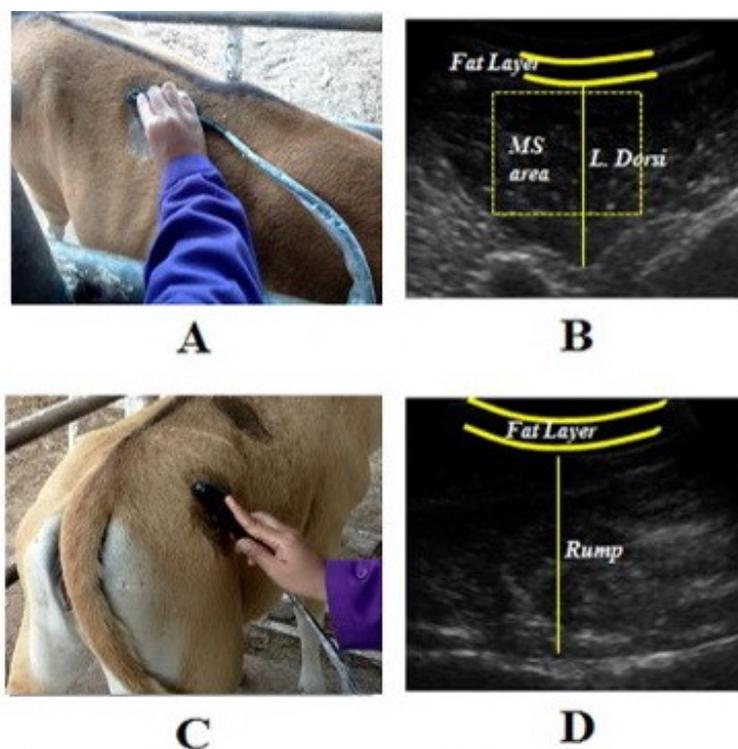


Figure 1. Applied Ultrasound Imaging Position and Ultrasound Image on the 12<sup>th</sup>-13<sup>rd</sup> Ribs (A and B) and between Ischium and Ilium bones (C and D).

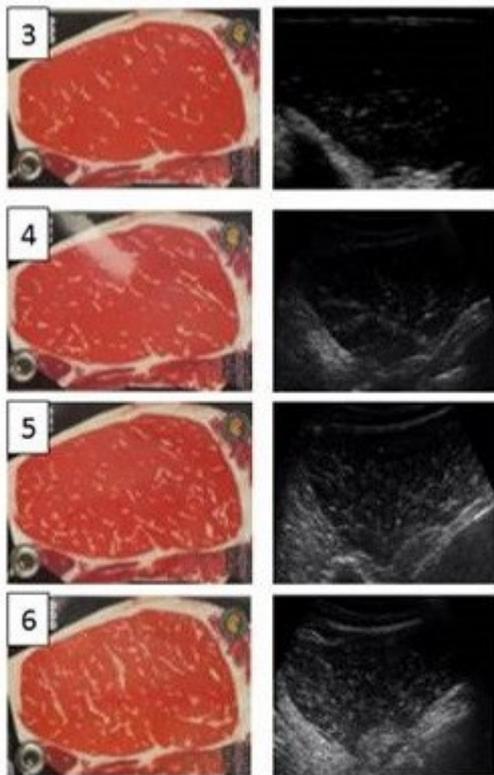


Figure 2. AUS-Meat Standard vs Ultrasound Image of Bali Cattle

(2016) reported that ultrasound backfat thickness of one year Bali cattle was 1.27 mm, lower than our result.

Several studies presented that different cattle breed has variation of marbling score (MS) such as MS of Sumba Ongole was 2-3 (Priyanto *et al.* 2015), Limousin and Shorthorn were 3 and 4, respectively (Cundiff *et al.*, 1993). Those variation caused by several factors, such as the type of feed, genetics and conditions of the animal where the animal is located (Pollan, 2006). The genetics from several gene were reported influenced in marbling development such CAPN1, FTO, SREBP1, FABP4 (Cheong *et al.*, 2008; Lee *et al.*, 2013; Shin *et al.*, 2012).

The MS and PIF showed intramuscular content as qualitatively and quantitatively. The PIF shows percentage of intramuscular fat area devived by longissimus dorsi muscle area on 12<sup>th</sup>-13<sup>th</sup> rib. This result shows PIF of cattle from PT KAR higher than BPTU-HPT Bali Province. Albrecht *et al.* (2006) showed that intramuscular fat content of Angus steer aged 7.5 and 13 months were 3.2% to 2.9%, lower than PIF of this study (female: 3.43% and male: 4.03%). Yang *et al.*

Table 2. Body Weight and Carcass Quality of Bali Cows

Variable	Age (year)	
	1	3
BW (kg)	86.77±20.04	198.83±23.41
LD (mm)	33.60± 4.90	53.94±5.40
BF (mm)	1.59± 0.40	5.39±0.54
RT (mm)	40.55± 4.89	58.11±5.80
RF (mm)	1.17± 0.47	5.76±0.57
MS	1.92± 1.19	4.50±1.05
PIF (%)	3.43± 2.26	13.48±3.42

BW= body weight; BF = backfat thickness; LD= longissimus dorsi thickness; RF = rump fat thickness; RT= rump thickness; MS = marbling score and PIF = percentage of intramuscular fat.

(2006) reported that intramuscular fat content increase from 12 to 14 month of age.

Correlation coefficient among carcass quality characteristics had high positive and significant correlation ( $P<0.01$ ) as presented in Table 4. The BW and LD had the strongest positive correlation (0.938) and the BW and MS had the weakest positive correlation (0.291). Correlation coefficient of BF and MS on Bali cattle in this study (0.548) was higher than crossbred cattle in Canada (0.34) reported by Miar *et al.* (2014). The correlation of intramuscular fat with animal were high while this value  $\geq 2\%$  (Aas *et al.*, 2009). Sarwono (2006) mentioned that positive correlation coefficient value had 6 categories which are perfect correlation (its value is 1.00), very strong positive correlation (the value about 0.75-0.99), strong positive correlation (the value about 0.50-0.75), moderate correlation (the value about 0.25-0.500), weak correlation (the value about 0.01-0.25) and no correlation (if it value is 0.00).

This result of the study is in agreement to Peña *et al.* (2014) that correlation between ultrasound and carcass longissimus muscle measurement (rib eye area, fat thickness and intramuscular fat content/marbling) of Charolais, Limaosin and Retinta cattle apporoximately about 0.251 to 0.625. Applying ultrasound measurement of carcass quality closer to slaughter resulting correlation coefficient between ultrasound and

Table 3. Body Weight and Carcass Quality of Bali Bull

Variable	Age (year)			
	1	3	4	6
BW (kg)	98.47±21.75	316.06±104.00	373.04±69.97	465.60±47.37
LD (mm)	32.65± 5.30	50.84± 9.38	57.98± 7.53	68.95±10.45
BF (mm)	1.36± 0.28	1.59± 0.51	2.28± 0.84	3.29± 0.60
RT (mm)	39.75± 3.51	82.23± 5.59	82.28± 8.90	90.24±11.38
RF (mm)	1.00± 0.20	-	-	-
MS	2.65± 1.22	2.60± 1.12	3.00± 1.21	3.80± 0.84
PIF (%)	4.03± 2.02	7.49± 3.91	11.09± 4.39	10.31± 2.15

BW= body weight; BF = backfat thickness; LD = longissimus dorsi thickness; RF = rump fat thickness; RT = rump thickness; MS = marbling score and PIF = the percentage of intramuscular fat

Table 4. Correlation Coefficient among Traits of Bali Cattle

	BW	LD	BF	TR	MS	PIF
BB		0.938**	0.457**	0.775**	0.291**	0.571**
TLD			0.587**	0.710**	0.384**	0.637**
BF				0.214	0.548**	0.660**
TR					0.097	0.373**
MS						0.761**
PIF						

(\*) significant correlation ( $P \leq 0.05$ ); (\*\*) significant correlation ( $P \leq 0.01$ ); BW= body weight; BF = backfat thickness; LD = longissimus dorsi thickness; RT = rump thickness; MS = marbling score and PIF = the percentage of intramuscular fat.

carcass quality increased to higher value and gave impact on accuracy determination especially for lean cattle (Tait, 2016). Moreover, Tait (2016) reported that there was high genetic correlations ( $\geq 0.5$ ) between ultrasound-measured body composition with carcass attributes in harvested cattle and lambs. The heritability of ultrasound backfat thickness and marbling score are high, both of them have heritability value about  $0.31 \pm 0.11$  and  $0.37 \pm 0.11$ , respectively. There was strong genetic correlation of ultrasound measurement with carcass merit, this evidence showed that ultrasound imaging technology could be used as an indicator for genetic improvement programs for carcass characteristics (Miar *et al.*, 2014). Application of ultrasound imaging to

estimate carcass quality of Bali cattle as a simple technique of recording could be used for breeding purposes as a Bali cattle has small body frame.

## CONCLUSION

In conclusion, carcass quality performances of Bali cattle were influenced by sex, age, environment and measurement methods. The characteristics of carcass quality on Bali cattle could be estimate using ultrasound imagery. Relationship among Bali cattle carcass quality characteristic had strong positive correlation coefficient about 0.291-0.938 and this data might be used for selection of more than one traits in carcass quality of Bali cattle.

## ACKNOWLEDGMENT

The authors would like to thank Ministry of Research Technology and Higher Education that supported the research with scheme number 079/SP2H/LT/DRPM/II/2016. We also appreciate The Director of BPTU-HPT Bali Province and The Director of PT. KAR Rumpin Bogor to provide the facility for this research.

## REFERENCES

- Albertí, P., G. Ripoll., F. Goyache, F. Lahoz, J.L. Olleta, B. Panea and C. Sañudo. 2005. Carcass characterization of seven Spanish beef breeds slaughtered at two commercial weights. *Meat Sci.* 71:514–521.
- Albrecht, E., F. Teuscher, K. Ender and J. Wegner. 2006. Growth and breed-related changes of marbling characteristics in cattle. *J. Anim. Sci.* 84 (5): 1067-1075
- Brethour, J. R. 2000. Using serial ultrasound measures to generate models of marbling and backfat thickness changes in feedlot cattle. *J. Anim. Sci.* 78: 2055–2061.
- Carvalho, M. da C. de., Soeparno and N. Ngadiyono. 2010. Pertumbuhan dan produksi karkas sapi Peranakan Ongole dan Simmental-Peranakan Ongole jantan yang dipelihara secara *feedlot*. *Buletin Peternakan.* 3: 38-46.
- Cheong, H.S., D.H.Yoon, B.L.Park, L.H. Kim, J.S. Bae, S.Namgoong, H.W. Lee, C.S. Han, J.O. Kim, I.C. Cheong, H.D. Shin. 2008. A single nucleotide polymorphism in *CAPNI* associated with marbling score in Korean cattle. *BMC Genetics.* 9(33): 111-120
- Cundiff, L.V., F. Szabo, K.E. Gregory, R. M. Koch, M.E. Dikeman and J.D. Crouse. 1993. Breed comparisons in the germplasm evaluation program at MARC. *Proc. Beef Improv. Fed. Ann. Res. Sym. and Ann. Mtg.* pp. 124-136.
- Deaton, A.V.W. and G. Rouse. 2000. USOFT: An ultrasound image analysis software for beef quality research. Beef research report. A.S. Leaflet R1437. Iowa University. Iowa
- Gupta, S., A. Kumar, S. Kumar, Z.F. Bhat, H.R. Hakeem and A.P.S. Abrol. 2013. Recent trends in carcass evaluation techniques—a review. *J. Meat Sci. Technol.* 1: 50-55.
- Greiner, S. P., G. H. Rouse, D. E. Wilson, L. V. Cundiff†, and T. L. Wheeler. 2003. Prediction of retail product weight and percentage using ultrasound and carcass measurements in beef cattle. *J. Anim. Sci.* 81:1736-1742.
- Hafid H. And N. Rugayah. 2009. The Percentage of Carcass in Different Body Weight and Fasting Period Prior to Slaughtering of Bali Cattle. *Proceedings. National Seminar on Animal Technology and Veterinary.* Place and date unknown. 2009. P. 77-85
- Irshad, A., G. Kandeepan, S. Kumar, A. Kumar, M.R. Vishnuraj and V. Shukla. 2012. Factors influencing carcass composition of livestock: a review. *J Anim. Prod. Adv.* 3:177-186.
- Jazulie, M.I., M. Nasich, T. Susilawati and Kuswati. 2015. Distribusi komponen karkas sapi brahman cross (BX) hasil penggemukan pada umur pemotongan yang berbeda. *Jurnal Ilmu Ilmu Peternakan.* 25: 24-34.
- Khasanah, H., A. Gunawan, R. Priyanto, M. F. Ulum and Jakaria. 2016. Polymorphism of myostatin (MSTN) promoter gene and its association with growth and muscling traits in Bali cattle. *Med. Pet.* 39:95-103
- Kim, N., V. Amin, D. Wilson, G. Rouse, and S. Udpa. 1998. Ultrasound image texture analysis for characterizing intramuscular fat content of live beef cattle. *Ultrasonic Imaging.* 20: 191-205.
- Lambe, N. R., D.W. Ross, E.A. Navajas, J.J. Hyslop, N. Prieto, C. Craigie, L. Bünger, G. Simm and R. Roehe. 2010. The prediction of carcass composition and tissue distribution in beef cattle using ultrasound scanning at the start and/or end of the finishing period. *Livest Sci.* 131: 193–202.
- Lee, J.H., S.H. Oh, Y.M. Lee, Y.S. Kim, H.J. Son, D.J. Jeong, N.C. Whitley and J.J. Kim. 2014. Study on growth curve of longissimus dorsi muscle area, backfat thickness and body conformation for Hanwoo (Korean native) cows. *AJAS.* 27: 1250-1253.
- Lee, Y., D. Oh, J. Lee, B. La, Y. Yeo. 2013. Novel single nucleotide polymorphisms of bovine *SREBP1* gene is associated with fatty acid composition and marbling score in commercial Korean cattle (Hanwoo). *Molecular Biology Report* 1: 247–254
- Martojo, H. 2012. Indigenous Bali cattle is most suitable for sustainable small farming in Indonesia. *Reprod Dom Anim.* 47:10–14.
- May, S. G., W. L. Mies, J. W. Edwards, J. J. Harris, J. B. Morgan, R. P. Garrett, F. L.

- Williams, J. W. Wise, H. R. Cross and J. W. Savell. 2000. Using live estimates and ultrasound measurements to predict beef carcass cutability. *J. Anim. Sci.* 78:1255–1261.
- Melendez L.J, and J.A. Marchello. 2014. The efficacy of ultrasound to determine certain carcass traits in grain-fed beef cattle. *Int. J. Sci. Comm. Hum.* 2:145-154.
- Miar, Y. G., S. Plastow, H. L. Bruce, S. S. Moore, O. N. Durunna, J. D. Nkrumah, and Z. Wang. 2014. Estimation of genetic and phenotypic parameters for ultrasound and carcass merit traits in crossbred beef cattle. *Can. J. Anim. Sci.* 94: 273-280.
- Peña, F., A. Molina, M. Juárez, F. Requena, C. Avilés, R. Santos, V. Domenech and A. Horcada. 2014. Serial ultrasound measures in the study of growth- and breed-related changes of ultrasonic measurements and relationship with carcass measurements in lean cattle breeds. *Meat Sci.* 96:247-255.
- Pollan, M. 2006. *Dilema omnivora*. The Penguin Press. Inc. New York.
- Priyanto, R., M.F. Asnath, L.A. Edit, M. Baihaqi and M. Ismail. 2015. Peningkatan produksi dan kualitas daging sapi lokal melalui penggemukan berbasis sereal pada taraf energi yang berbeda. *J. Ilmu Pertanian Indonesia.* 20:108-114.
- Sarwono, J. 2006. *Metode Penelitian Kuantitatif dan Kualitatif*. CV. Graha Ilmu Yogyakarta.
- SAS. 2008. *SAS/STAT 9.2 User's Guide The GLM Procedure (Book Excerpt)*. SAS Institute Inc. SAS Campus Drive. Carolina
- Shin, S.C., J.P. Heo, E.R. Chung. 2012. Genetic variants of the *FABP4* gene are associated with marbling scores and meat quality grades in Hanwoo (Korean cattle). *Molecular Biology Report.* 5:5323–5330
- Silva, S.L., J.U. Tarouco, J.B.S.Ferraz, da C. Gomes, P.R. Leme and E.A.Navajas. 2012. Prediction of retail beef yield, trim fat and proportion of high-valued cuts in Nellore cattle using ultrasound live measurements. *R. Bras. Zootec.* 41:2025-2031.
- Tait, R.G., 2016. Ultrasound use for body composition and carcass quality assessment in cattle and lambs. *Vet. Clin. Food Anim.* 32: 207–218.
- Ulum, M.F., E. Suprpto and Jakaria. 2014. Ultrasonography image of Longissimus dorsi muscle of Bali cattle. *Proceeding. KIVNAS PDHI XIII. Konverensi Ilmiah Veteriner Nasional ke-13 Perhimpunan Dokter Hewan Indonesia, Padang, Indonesia, Nov. 23-26, 2014.* P. 368-369.
- USDA. 2014. *Carcass Beef Grades and Standards.* <https://www.ams.usda.gov/grades-standard/carcass-beef-grades-and-standards>.
- Wiyatna, M.F. 2007. Perbandingan indeks kualitas daging sapi-sapi Indonesia (Sapi Bali, Madura, PO) dengan Sapi Australian Commercial Cross (ACC). 7:22-25.
- Yang, X. J., E. Albrecht†, K. Ender†, R. Q. Zhao\* and J. Wegner. 2006. Computer image analysis of intramuscular adipocytes and marbling in the longissimus muscle of cattle. *J. Anim. Sci.* 84(12): 3251-3258.
- Yantika, S.M., Alamsyari, D. Evvyernie, D. Diapari and K. Winaga. 2016. Performance, carcass production, and meat quality of sumba ongole bulls fed ration supplemented velvet bean (*Mucuna pruriens*). *Med. Pet.* 39:20-26.