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Prediction of meat quality in Bali cattle using ultrasound imaging

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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 *longissmus dorsi* (LD), tebal lemak *rump* (RF), tebal *rump* (RT), skor *marbling* (MS) dan persentase lemak intramuskuler (PIF) diukur menggunakan ultrasonografi. Pengambilan citra ultrasnonografi 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 karaktersitik 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), longissmus 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^{th}-13^{th} 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 (Martojo, 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 (Croosbred of Simmental-Ongole Gradea) bout 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, particulary 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 slaugther 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 catle (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 carcas 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), longissmus dorsi thickness (LD), rump fat thickness (RF), rump thickness (RT), marbling score (MS) and the percentage of intramuscular fat (PIF). Carcass quality atributes were estimated using ultrasound linier transducer with frequency 4.5 to 6.5 MHz with a depth of 8.8 to 13 cm. Aplication 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, aplication 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 environtment. 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±0.40 mm and then a sharp increase ensue to more than one years cattle, the BF about 5.39±0.54 mm. The BF of three years old Bali bull only 1.59±0.51 mm lower than Lee *et al.* (2014) that reported ultrasound backfat thickness of three years old Hanwoo cattle was 5.10 ± 2.60 mm with an area of rib about 51.20±7.7 cm^2. 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

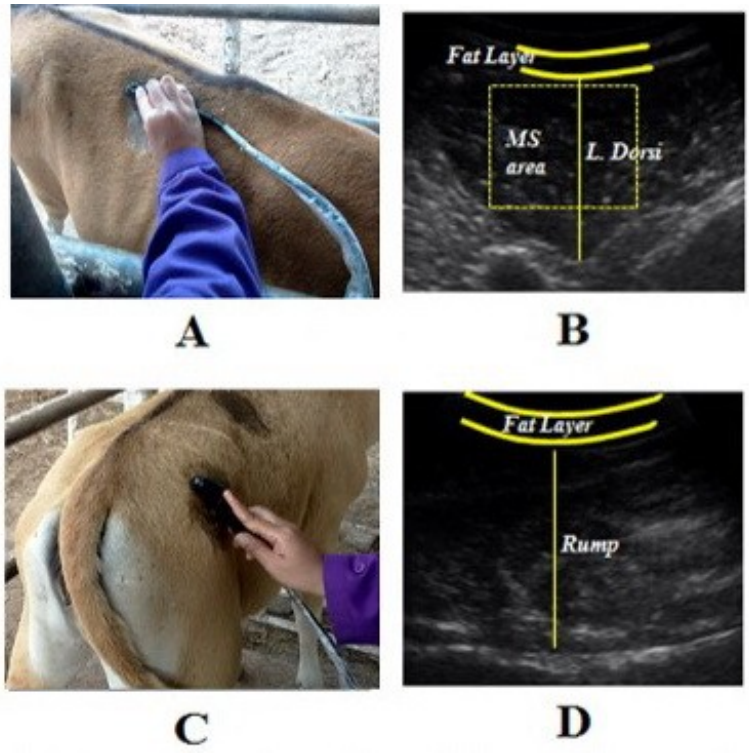

Figure 1. Applied Ultrasound Imaging Position and Ultrasound Image on the 12^{th}-13^{rd} Ribs (A and B) and between Ischium and Illium bones (C and D).

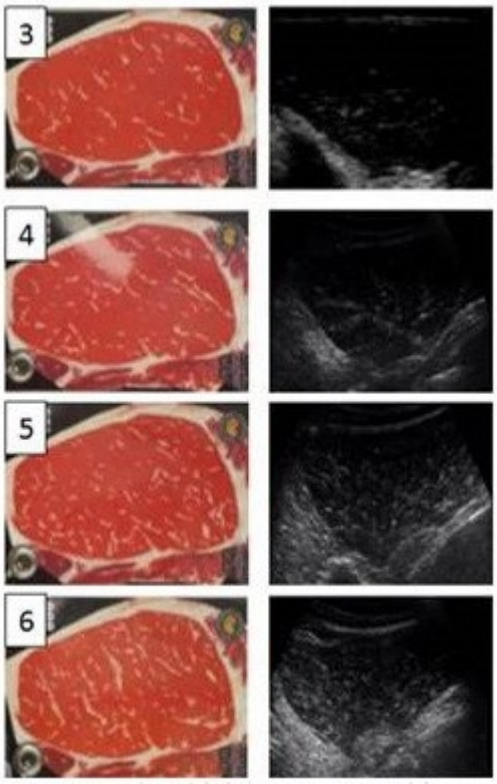

Figure 2. AUS-Meat Standard vs Ultrasound Image of Bali Cattle

(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 12th-13th 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= longissmus 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 coefficien 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 ≥ 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 = longissmus 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≤0.05); (**) significant correlation (P≤0.01); BW= body weight; BF = backfat thickness; LD = longissmus 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 (≥0.5) between ultrasound–measured body compotiotion 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±0.11 and 0.37±0.11, respectively. There was strong genetic corelation 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). Aplication 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.

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