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Accuracy of chest girth to predict body weight in native cattle of Indonesia

HARTATI[1]✉ and W P B PUTRA[2]

Indonesian Beef Cattle Research Station, Grati, Pasuruan, East Java, 67184, Indonesia

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Body weight (BW) is an important traits that used as the selection criteria for meat production. In beef cattle, the BW has highly correlation value (r=0.90) with carcass weight (Coyne *et al.* 2019, Prihandani *et al.* 2020). Nevertheless, BW of cattle was difficult to obtain in the smallholds with no animal weighing scale. However, the BW in cattle can be predicted with body measurements through linear regression analysis. Thus, the best linear regression equation can be detected according to coefficient of determination (R^2) value. The linear regression equation with highly of R^2 value indicates that this equation can be used to predict BW accurately. Recently, chest girth (CG) has been reported as the best measurement for predicting BW of cattle with highly of R^2 value (Odadi 2018, Vanvanhossou *et al.* 2018).

Prediction of BW with CG measurement is very easy to apply in smallholds. So, selection of cattle can be performed in the village breeding center (VBC) through predicted weight. Recently, the predicted weight tape was available in the many farmer shops. Nevertheless, the predicted weight according to the predicted weight tape is over 18 kg from actual weight (Barata *et al.* 2019). Hence, the regression analysis with CG to estimate BW of cattle is important to obtain predicted weight close to actual weight. This study was aimed to observe the accuracy of CG for predicting BW in three native cattle of indonesia raised at Indonesian Beef Cattle Research Station. The results in this study is very usefull in the selection program at VBC in the future.

The following experiment was conducted under the guidelines of the Indonesian Code of Practice for the Care and Use of Animals for Scientific Purposes and was approved by the Indonesian Ministry of Agriculture Animal Ethics Committee (Balitbangtan/Lolitsapi/Rm/02/2018) and Balitbangtan/Lolitsapi/Rm/07/2018. It has met the ethical and animal welfare requirements. Amount of 544 animals (about 3 years of age) were used in this study and obtained from three native cattle breeds of Indonesian Ongole grade (200 heads), Madura (198 heads) and Bali (146 heads). All cattle that used in this study were raised at Indonesian Beef Cattle Research Center, Grati District, Pasuruan Regency, East Java Province of Indonesia. The animals were kept in the colony stall with natural mating system. Each stall consisted of 1 bull and 15 to 20 cows. The forages feed consisted of 80% of Elephant grass (*Pennisetum purpureum*), 20% of legume and rice straw was given *ad lib*. The concentrate feed consisted of the agricultural, plantation and agroindustries by products with nutrient contents were about 10–12% crude protein (CP), 58–60% total digestible nutrient (TDN) and 18–22% crude fiber (CF).

The ration ingredients and its formulation were not permanent, it depend on the availability of feedstuff. The ration was adjusted to the physiological status of the cattle. Generally, cattle consumed 2.5–3.5% of their BW. The standard nutritional content of feed for Ongole grade, Madura and Bali cattle was presented in Table 1. Moreover, the fresh water was given ad libitum with regular medical examination and vaccination.

Data of BW and CG measurement were collected from year 2009 to 2019. The BW was obtained using digital weight scale (Thru-Test, Canada). Meanwhile, the CG was measured with a tape measure (Butterfly, China) as circumference of the chest just behind the foreleg (fourth *os costa*). Data of BW and CG were analyzed using SPSS 16.0 computer program to obtain mean, standard deviation (SD) and Pearson's coefficient of correlation (r) among variable. The T-test analysis was performed in this study to observe the sex effect using similar software. The simple linear regression was made by BW as dependent variable and CG as independent variable. The simple linear regression was performed using similar software to obtain coefficient of determination (R^2) value between BW and CG. Hence, the R^2 value is important to select the best regression equation to predict BW.

The average BW in Ongole grade cattle was highest than in Madura and Bali cattle as presented in Table 2. Meanwhile, the average of CG in Ongole grade and Madura

Present address: [1]Indonesian Beef Cattle Research Station, Grati, Pasuruan, East Java, Indonesia. [2]Research Center for Biotechnology-Research Organization for Life Sciences-National Research and Innovation Agency (BRIN), Cibinong, West Java, Indonesia. ✉Corresponding author email: hartatifakhri16@gmail.com

Table 1. The nutritional content standard of feed for cattle at breeding station

Physiological status	Nutritional content (DM)		
	Min (% CP)	Min (TDN %)	Max (CF %)
Dry period	10	58	22
Mating, pregnant - weaning	12	60	22
Weaning calves - 24 months	12	60	18
Sire candidate (>18 months) and sire	10	58	22

DM, dry matter; CP, crude protein; TDN, total digestible nutrient; CF, crude fibre.

were showed similar. The previous studies showed Putra (2020) reported that the average of BW in Sumba Ongole cattle raised at breeding station were 299.18±89.31 kg (male) and 226.59±92.83 kg (female), showed lower than Ongole grade cattle in this study. Prihandini *et al.* (2020) reported that the average of BW in Madura bull (3 years of age) and cow (4 years of age) at Pamekasan District (Indonesia) were 306.66±95.04 kg and 282.76±71.59 kg respectively, showed higher than Madura cattle in this study. Thus, Garantjang *et al.* (2020) reported that the average BW in Bali bulls (2.6 to 3.0 years of age) and cows (3.1 to 4.0 years of age) raised in a breeding station at South Sulawesi (Indonesia) were 246.58±34.54 kg (male) and 216.46±32.87 kg respectively. The different of the BW of cattle in this study compared to previous studies can be caused by different of managements system and feed nutrition. The Pearson coefficient of correlation (r) between BW and CG in pool animal was ranged from 0.79 to 0.91 (male) and 0.71 to 0.90 (female) as presented in Table 3.

The very high r value (0.81<r<1.00) between BW and CG has been reported in Muturu cattle (0.94), Bali (0.83)

Table 2. Means (±SD) of age, BW and CG in native cattle breeds of Indonesia

Sex / measurement	Breed		
	Ongole grade	Madura	Bali
Male			
Number of animal (heads)	100	34	20
Age (years)	2.75± 0.16[a]	2.74± 0.20[a]	2.87± 0.47[b]
Body weight (kg)	364.02± 64.61[a]	265.10± 84.76[b]	320.15± 75.08[c]
Chest girth (cm)	168.01± 10.96[a]	150.96± 18.60[b]	166.70± 20.41[a]
Female			
Number of animal (heads)	100	164	126
Age (years)	2.70± 0.25[a]	2.99± 0.21[b]	3.27± 0.23[c]
Body weight (kg)	284.27± 52.40[a]	202.60± 49.14[b]	168.09± 35.72[c]
Chest girth (cm)	154.40± 9.50[a]	141.45± 12.59[b]	135.12± 10.61[c]

[a,b,c]superscript in the similar row differ significantly (P<0.05).

Table 3. Pearson's coefficient of correlation between BW and CG in native cattle breeds of Indonesia

Breed	Male	Female
Ongole grade	0.91**	0.90**
Madura	0.88**	0.81**
Bali	0.79**	0.71**

**(P<0.01).

Table 4. Simple linear regression equations to predict BW with body measurements in three native cattle breeds of Indonesia

Breed	Sex	Equation	R^2	SE
Ongole grade	Male	5.35(CG) - 535.09	0.84	26.09
	Female	4.96(CG) - 480.63	0.80	23.25
Madura	Male	4.02(CG) - 340.93	0.78	40.70
	Female	3.15(CG) - 242.60	0.65	29.15
Bali	Male	2.90(CG) - 163.98	0.62	47.35
	Female	2.39(CG) - 154.42	0.50	25.29

R^2, coefficient of determination; SE, standard error of regression; WH, withers height; HH, hip height; BL, body length; CG, chest girth.

Yerli Kara (0.88) and Jabres (0.99) cattle (Daikwo *et al*. 2018, Agung *et al.* 2018, Sakar *et al.* 2020, Haq *et al.* 2020). Thus, high category r value (0.60<r<0.80) between BW and CG were showed in Bali (0.70) cattle (Tisman and Putra 2015). The different result between previous and present studies can be caused by different of animals age, environment and breed (genetic) factors.

The coefficient of determination (R^2) value in pool animals ranged from 0.62 to 0.84 (male) and 0.50 to 0.80 (female) as presented in Table 4.

According to Table 4, the R^2 of Ongole grade cattle was the highest than the others. In addition, the R^2 value in male cattle (bulls) was higher than female cattle (cows). Previous studies reported that simple linear regression using BW (dependent variable) and CG (independent variable) reveal of very high R^2 value ($0.81<R^2<1.00$) in Boran cross (0.90), Somba (0.94), Muturu cattle (0.91), Sumba Ongole (0.94) and Jabres (0.99) cattle (Odadi 2018, Vanvanhossou *et al.* 2018, Daikwo *et al*. 2018, Putra 2020, Haq *et al.* 2020). Meanwhile, high category of R^2 value ($0.61<R^2<0.80$) has been reported in Lagune (0.73) and Yerli Kara (0.77) cattle (Comlan *et al.* 2017, Sakar *et al.* 2020). Thus, the low R^2 value ($0.21<R^2<0.40$) in simple linear regression with BW and CG was reported in Bali cross (0.53) and Holstein Friesian crossbred (0.40) cattle (Tisman and Putra 2015, Ashwini *et al.* 2019). In Bali cattle, previous studies reported that the R^2 values in the simple linear regression with BW and CG variables were 0.49 (Tisman and Putra 2015), 0.69 (Agung e*t al.* 2018) and 0.73 (Jakaria *et al.* 2019).

The BW of Ongole grade cattle was influenced by CG variable about 80% and the remaining about 20% was influenced by other factors of cattle condition when measured and weighed, measurements method, accuracy of measuring instruments and others. Moreover, the

Table 5. The results of T-test analysis for actual and predicted weights with CG variable in three native cattle breeds of Indonesia

Breed	Sex	Body weight (kg)		P-value
		Actual	Predicted	
Ongole grade	Male	364.02±64.61	363.74±58.62	0.403
	Female	284.27±52.40	284.82±47.03	0.422
Madura	Male	265.10±84.76	265.91±74.78	0.506
	Female	202.60±49.14	202.92±39.68	0.050
Bali	Male	320.15±75.08	319.45±59.18	0.322
	Female	168.09±35.72	168.51±25.37	0.002

increasing 10 cm of CG in Ongole grade cattle will be followed by increasing BW of 53.5 kg (male) and 49.6 kg (female). According to the T-test analysis showed that the predicted and actual weights in Madura and Bali cows were different significantly ($P<0.05$) and reveal that the CG in both cows can not be used for BW prediction.

In conclusion, the CG measurement can be used to predict the BW in Ongole grade cattle at 2.70 years of age with very high of R^2 value (about 0.80). Hence, the BW in Ongole grade cattle can be predicted with simple linear regression equation of BW= 5.35(CG) - 535.09 (male) and BW= 4.96(CG) - 480.63 (female). Nevertheless, the R^2 value in the simple linear regression with CG (independent variable) for Madura and Bali cattle were included of moderate to high categories. Hence, the R^2 value of linear regression in both breeds needed to increase with large number of sample for predicting the BW accurately.

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