Relationship among Body Weight, Scrotal Circumference and Sperm Quantity of Bali Bulls in Baturiti Artificial Insemination Center

R Indriastuti¹, M F Ulum¹, R I Arifiantini¹, E Memili² and B Purwantara¹

¹Faculty of Veterinary Medicine, Bogor Agricultural University, West Java 16680, Indonesia
²Department of Animal and Dairy Sciences, Mississippi State University, 4025 Wise Center Box 9815, Mississippi State, Mississippi 39762, USA

purwantara1959@gmail.com

Abstract. Bali cattle are one of the native cattle breeds in Indonesia as a meat producer. The objective of this study was to analyze the correlation between body weight and scrotal circumference and sperm quantity of Bali bulls. To accomplish this objective, primary and secondary data of Bali bulls in Baturiti Artificial Insemination (AI) Center, Bali from 2017 to 2019 were used in this research, consisted of scrotal circumference (SC), body weight (BW), semen volume (SV) and sperm concentration (SCon) (n= 9 bulls in productive age). Total Number Sperm (TNS) was calculated multiply value of SV and SCon. The data were analyzed statistically using Correlation Pearson Square. There was no significant correlation among body weight, scrotal circumference, and sperm quantity of Bali bulls in this research (P>0.05). Low positive correlation was found between BW with SC (0.296), very low positive correlation with SV (0.049), very low negative correlation with SCon (-0.089) and moderate positive correlation with TNS (0.427). Moreover, SC showed low negative correlation with SCon (-0.202), very low negative correlation with SV (-0.028) and low positive correlation with TNS (0.286). In conclusion, BW showed positive correlation SC, SV and TNS, but showed a negative correlation SCon. SC had positive correlation with TNS but they showed negative correlation with SV and SCon of Bali bulls.

1. Introduction
Bali cattle are an Indonesian native breed that has many advantages, among others easy to adapt to various types of feed, environmental conditions and extreme climate changes, and have a good reproductive efficiency [1]. Bali cattle, as one type of beef cattle, has a fairly high percentage of carcasses, which is 51% [2] to 54% [3]. The value of service per conception (S/C) is 1.76 [4] to 1.84 [5] with the value of conception rate (CR) of 80.00-86.67% [6]. Bull reproductive efficiency can be assessed by semen quality. A good semen quality is necessary in increasing livestock populations, including the Bali cattle. The breeding of Bali cattle in Bali province is conducted through artificial insemination (AI) using frozen semen.

The rules prohibited the intrusion of new genetic resources from outside Bali while selling out cattle to other part of the country is allowed. The only frozen semen used for AI in Bali province come from
Baturiti AI Centre. The frozen semen production in Baturiti AI Centre referred to the Indonesian National Standard (SNI) of Bull Frozen Semen number 4869.1:2017, consisting of the value of post-thawing motility (PTM) > 40% with individual score > 2 and the concentration of sperm > 25x10^6 Al dose [7]. According to this regulation, Baturiti AI centre should be able to provide adequate quantities of Bali bull frozen semen to use for AI programs. Therefore, the superior bull used as a source of frozen semen is not only has a good semen quality, but also has the sufficient semen quantity, consisted of semen volume (SV), sperm concentration (Scon), and total number of sperm (TNS) per ejaculate. According to Devkota et al. [8] the sperm producing ability of Holstein bulls can be determined by many factors, including the measurement of body weight (BW) and scrotal circumference (SC). Devkota et al. [8] reported the positive correlation for BW with SV and Scon, and SC with SV and SCon. Latif et al. [9] showed that SC had a high positive correlation with SV, but very low positive correlation with SCon.

Considering Baturiti AI Center is the only producer of Bali bull frozen semen for AI program in Bali province, then it is important to evaluate the productivity of the frozen semen production of Bali bulls regularly. This research aims to analyze the correlation among body weight, scrotal circumference and sperm quantity of Bali bulls.

2. Materials and methods

2.1. Animal management
Nine Bali bulls in productive age used in this research. Bulls are maintained intensively and fed the amount of 50 kg of forages, 5 kg of concentrate feeds and ad libitum water intake. Semen collection was carried out twice a week. The bulls were exercised a day before semen collection.

2.2. Data Collection
This research used primary and secondary quantitative data. Primary data were collected during March and April 2019 from nine bulls in productive age in Baturiti AI Center, namely Mertasari, Blandar, Bugamanta, Bangkardi, Buwana Merta, Bangtidar, Bulbakanta, Busada Merta, and Budaparta. Semen ejaculates were collected by artificial vagina (n=5 times each bull) during March – April 2019. Ejaculates were evaluated immediately after collection for fresh semen quality, including SV and SCon. Secondary quantitative data collected were bull performance (BW and SC) and sperm quantity (SV and SCon). BW and SC obtained from monthly data were measured by a veterinarian in Baturiti AI center. Sperm quantity data was obtained from frozen semen production in Baturiti AI Center in the year 2017-2019 (n=68 times each bull). Bull performance was determined as dependent variable, meanwhile the independent variable was sperm quantity. Primary data obtained was combined with secondary data before doing the data analysis.

2.3. Semen Evaluation
SV and Scon was carried out in semen evaluation step. SV was measured by looking the numeral scale in the tube. SCon was calculated computerized using a Photometer SDM 6 (Minitub, Germany). Amount of 35 µL semen was mix with 3.5 ml of saline solution in a cuvet, covered by parafilm, and homogenized. The cuvet was placed in the photometer SDM and the bull identity was set before running the device. SV and SCon was calculated to obtain the total number of sperm (TNS) on each bull.

2.4. Statistical Analysis
The descriptive statistical analysis was used in this study to present the mean of bull performance (BW and SC) and sperm quantity (SV, SCon and TNS). The data were presented in mean and standard
deviation. To analyse the correlation between BW and SC to SV, SCon, and TNS, data were analyzed using Correlation Pearson Square in SPSS 21.0 application.

3. Results and Discussions

3.1. Mean and Standard Deviation of Bull Performance and Sperm Quantity

Table 1 presents the descriptive statistical analysis the mean of bull performance (BW and SC) and sperm quantity (SV, SCon and TNS). The results showed that BW of bull used in this study was 570.11–691.54 kg. This finding was higher than Rahayu [10] that was 350-400 kg. Bull in AI centre is well selected and maintain with optimum feeding and exercise system. There are many factors affecting the BW of bull, such as the season-born, feeding nutrition, feed converting ratio (FCR). Morsy et al. [11] reported that mature BW was affected by birth weight, pre- and post-weaning daily gain, and the level of energy in diet. Moreover, the variation of breed bulls also showed the different BW [12].

Table 1. Mean and standard deviation of bull performance and sperm quantity

| Variables                          | n   | Mean±SEM   | Minimum | Maximum |
|------------------------------------|-----|------------|---------|---------|
| Body weight (kg)                   | 9   | 629.29±46.36 | 563.39  | 691.54  |
| Scrotal Circumference (cm)         | 9   | 30.11±1.05  | 28      | 32      |
| Semen Volume (mL)                  | 9   | 6.28±1.61   | 4.45    | 9.11    |
| Sperm Concentration (10^9/mL)      | 9   | 1145.51±196.26 | 869.68  | 1476.83 |
| Total Number Sperm per ejaculate (10^9) | 9 | 5875.08±2529.21 | 2737.98 | 10558.02 |

The mean of SC obtained in this research was 30.11 cm (28-32 cm). The result was similar to the study reported by Saputra et al. [13] that SC of Bali bull was 30.10 cm. There are many factors affecting the measure of SC, such as age [14], breed [12, 15], birth weight, pre- and post-weaning daily gain, the level of energy in diet [11], and season [16]. SC is also influences by breed. Bali bull as a native bull had a smaller BW compare to other beef bull such as Simental. According to Eriksson et al. [12] Simmental bulls with BW around 600-700 kg shows SC around 35-37 cm.

Sperm quantity of Bali bull consists of SV, Scon and TNS. The mean of SV was 6.28±1.61 mL. The result obtained was higher than the study reported in previous study [17] showed that SV of Bali bull was 3.07-3.62 mL. Sumeidiana et al. [18] stated that breed, age and BW factor influencing the SV. According to Al-Anazi et al. [16] ejaculates SV obtained in spring was higher compared to SV in summer. The mean of SCon in this study was 1145.51±196.26x10^9/mL. The result obtained was higher than the study reported by Saputra et al. [13] that the Scon of Bali bull was 1033.76±3.61 million/mL. According to Al-Anazi et al. [16] Scon was affected by seasonal variation and nutrient component. TNS describes the number sperm in ejaculate. More SV and SCon, TNS will be obtained. The result showed that TNS of Bali bull was 2737.98 – 10558.02 x 10^6. Murphy et al. [19] reported that total number of sperm in ejaculate of Frisian Holstein bull was 5.5 x 10^9. The number of sperm production is influenced by ejaculates volume and TNS [19]. Al-Anazi [16] stated that TNS was affected by season.

3.2. Relationship among Body Weight, Scrotal Circumference, Semen Volume, Sperm concentration, and Total Number of Sperm on Bali bulls

The correlation between BW and SC was shown in Table 2. The result showed that SCon, SV, and TNS were not significantly affected by BW and SC (P>0.005). BW had low positive correlation with SC (0.296), which means that more value of BW, more SC measured. Perumal [14] stated a strong positive correlation was obtained for BW and SC (0.89) in Tho Tho (Bos indicus) bulls.

BW has a very low positive correlation with Vol (0.049). This indicated that bull with higher BW secretes the higher value of SV. This finding was similar to Devkota et al. [8] showed that BW had low positive correlation with SV. The bulls with higher BW showed that they have the higher SC [12].

Table 2. Relationship among body weight, scrotal circumference and sperm quantity
A very low negative correlation BW and SCon was found in this study (-0.089). This finding was in disagree with Devkota et al. [8] showed that BW had low positive correlation with SCon. The result obtained showed BW had a medium positive correlation with TNS (0.427). This result means that more BW of bulls, more TNS will be resulted in ejaculates.

A non-significant negative correlation (P>0.05) between SC with SV (-0.028) was obtained. This result means that the bigger SC, the lower SV obtained. This finding showed the different result with previous studies [8, 21] reported that SC had a low positive correlation with SV. This finding on this research might be influenced by accessory sex glands secretions. Semen is composed of spermatozoa and plasma seminal fluid. Setchell [21] reported that the sperm is only 10% content of the SV, while the rest (90%) is the seminal plasma. Moreover, Ndovi [22] stated that ejaculate volume is depend of accessory gland secretions which known as seminal plasma (<10% of urethral and bulbourethral gland secretion, 20–40% of prostatic secretion, <10% of testicular-epididymis secretion and 50–80% of seminal vesicle secretion). The other factors may affect the SV were the testes thermoregulation and hormonal regulation. According to [23], the sperm output was influenced by the histological, histochemical, hypothalomo-pituitary stimulation, the surface area and the thermoregulatory mechanism of the testes.

Although SC showed a low negative correlation with SCon (-0.202), but it was not significantly correlated (P<0.05). It indicated that a bigger SC resulted the lower SCon. This was in disagree with previous studies [8, 9] that reported that SC had a positive correlation with SCon. The present finding of low negative correlation for SC with SCon might be affected by many factors, such as the potential output of spermatozoa which depends on the function of total testicular mass (germ cells activity). According to Senger [24] both testes in normal bulls are able to produce <1 to 25 billion spermatozoa per day or around 35,000 – 200,000 sperm per second. Moreover, the sperm production might be not only influenced by SC, but also was influenced by the shape of testes. Bailey et al. [23] found that the shape of testes should be paid attention to predict the sperm production in Holstein bulls besides the SC or testicular volume.

A low positive correlation between SC with TNS was resulted in this study (0.286), which indicated that a bigger SC, more TNS will be obtained. This result was in accordance to Latif et al. [9] and Sarlós et al. [20]. SV had a high positive correlation with TNS (0.612) although it was non-significant correlated. It indicated that the increasing of SV will be followed by the increasing of TNS. This finding was similar to the research of Sarlós et al. [20] reported the high positive correlation between SV and TNS cells per ejaculate (0.89).

### 4. Conclusion

Body Weight showed a positive correlation between semen volume and total number sperm, but showed negative correlation in sperm concentration. Scrotal Circumference had positive correlation with the total number of sperm but had a negative correlation with volume and sperm concentration of Bali bulls.

### Acknowledgments

This work is supported by Ministry of Research, Technology and Higher Education of the Republic Indonesia through PMDSU scholarship, USAID through Sustainable Higher Education Research Alliances (SHERA) Program–Center for Collaborative Research Animal Biotechnology and Coral Reef

| BW   | SC  | SV  | SCon | TNS |
|------|-----|-----|------|-----|
| 1    | 0.296 | 0.049 | -0.089 | 0.427 |
| 1    | -0.028 | -0.202 | 0.286 |
| 1    | 0.137 | 0.612 |
| 1    | 0.546 |

BW: Body weight; SC: Scrotal circumference; SV: Semen volume; SCon: Sperm Concentration; TNS: Total Number of Sperm. Values with superscripts are significantly correlated (P<0.05).
Fisheries (CCR ANBIOCORE). The authors are also grateful to Baturiti AI center, and Laboratory of Rehabilitation Reproductive Unit, Faculty of Veterinary Medicine, IPB University.

References

[1] Suranjaya I, Ardika I and Indrawati R 2010 Faktor-Faktor yang mempengaruhi produktivitas sapi bali di wilayah binaan proyek pembibitan dan pengembangan Sapi Bali di Maj. Ilm. Petern. 13(3) 83–87
[2] Hafid H, Nuraimi N, Inderawati I and Kurniawan W 2018 Bali Cattle carcass characteristic of different butt shape condition IOP Conf. Ser. Earth Environ. Sci. 119(1) 1-9
[3] Suryanto E, Bulkaini B, Soeparno S and Karda I W 2017 Kualitas Karkas, marbling, kolesterol daging dan komponen non karkas sapi bali yang diberi pakan kultur buah kakao fermentasi Bul. Petern. 41(1) 72-78
[4] Suharyati S and Hartono M 2017 Pengaruh manajemen peternak terhadap efesiensi reproduksi sapi bali di kabupaten pringsewu Provinsi Lampung J. Penlit. Pert. Terapan 16(1) 61–67
[5] Gunawan M, Ka’im E M and Ridwan R 2017 Peningkatan produktivitas sapi Bali melalui inseminasi buatan dengan sperma sexing di Techno Park Banyumulek, Nusa Tenggara Barat, In Pros Sem Nas Masy Biodiv Indon, Bogor, Indonesia, September 9, 2017 3(2) 216–219
[6] Mardiansyah, Yuliani E and Prasetyo S 2016 Respon tingkah laku birahi, service per conception, non return rate, conception rate pada sapi bali dara dan induk yang disinkronisasi birahi dengan hormon progesteron J. Ilmu dan Tek. Pet. Indonesia I(1) 134–143
[7] [BSN] Badan Standarisasi Nasional 2017 SNI 4869-1:2017 Semen beku – Bagian 1: Sapi. Jakarta: BSN
[8] Devkota B, Koseki T, Matsui M, Sasaki M, Kaneko E 2007 Relationships among age, body weight, scrotal circumference, semen quality and peripheral testosterone and estradiol concentrations in pubertal and postpubertal holstein bulls Theriogenology 1 6–8
[9] Latif M, Ahmed J U, Bhuiyan M M U and Shamsuddin M 2009 Relationship between scrotal circumference and semen parameters in crossbred bulls Bangladesh Vet. 26(2) 61–67
[10] Rahayu S 2015 The reproductive performance of Bali cattle and it’s genetic variation J. Biol. Res. 20(1) 28–35
[11] Morsy N H A, Hassan H A, Makarechian M and El-Feel F M R 1998 Factors affecting body weight, scrotal circumference, hip height and their relationships with birth weight, preweaning and postweaning gains in young bulls J. Appl. Anim. Res. 13(1–2) 81–92
[12] Eriksson P, Lundheime N, Söderquist L 2012 Changes in mean scrotal circumference in performance tested Swedish beef bulls over time Acta Vet. Scand. 54 74
[13] Saputra D, Ihsan M and Isnaini N 2017 Korelasi antara lingkar skrotum dengan volume semen, konsentrasi dan motilitas spermatozoa pejantan Sapi Bali J. Trop. Anim. Prod. 10(2) 59–68
[14] Perumal P 2014 Scrotal circumference and its relationship with testicular growth, age, and body weight in the (Bos indicus) bulls Int. Sch. Res. Not. 2014 1–6
[15] Menegassi S R, Barcellos J O, Peripolli P, Pereira P R R, Borges J B and Lampert V 2011 Measurement of scrotal circumference in beef bulls in Rio Grande do Sul Arq. Bras. Med. Veterinária e Zootec. 63(1) 87–93
[16] Al-Anazi Y, Al-Butayni M G, Al-Ghadi M, Alfurayji M M, Al-himaidi A R and Ammari A 2017 Seasonal variations in scrotal circumference and semen characteristics of Naimi and Najdi rams in Saudi Arabia South African J. Anim. Sci. 47(4) 454–459
[17] Haryani R, Toleng A L, Sonjaya H and Yusuf M 2016 Characteristic of bali bulls sperms assessed using computerized assisted semen analysis (CASA) LISBAR 28(2) 161–168
[18] Sumeidiana I, Wuwuh S and Mawarti E 2007 Semen Volume and sperm concentration of Simmental, Limousin and Brahman Cattles in Ungaran of artificial insemination center J. Indonesian Trop. Anim. Agric. 32(2) 131–137
[19] Murphy E M, Kelly A K, O’Meara C, Eivers B, Lonergan P and Fair S 2018 Influence of bull age, ejaculate number, and season of collection on semen production and sperm motility
parameters in holstein friesian bulls in a commercial artificial insemination centre. J. Anim. Sci. 96(6) 2408–2418

[20] Sarlós P, Eggerszegi I, Balogh O, Molnár A, Cseh S and Rátky J 2013 Seasonal changes of scrotal circumference, blood plasma testosterone concentration and semen characteristics in Racka rams Small Rumin. Res. 111(1–3) 90–95

[21] Setchell B P 2014 Semen and Its Constituent, in Animal Andrology Theories and Applications, L S Peter and J Chenoweth, Ed. Wallington (UK: CAB International) pp 1–10

[22] Ndovi T T, Parsons T T, Choi L, Caffo B, Rohde C and Hendrix C W 2007 A new method to estimate quantitatively seminal vesicle and prostate gland contributions to ejaculate Br. J. of Clin. 63(4) 404–420

[23] Bailey T L, Monke D, Hudson R S, Wolfe D F, Carson R L and Riddell M G 1996 Testicular shape and its relationship to sperm production in mature Holstein bulls Theriogenology 46(5) 881–887

[24] Senger P L 2003 Pathways to Pregnancy and Parturition. Second Edition (USA: Current Conceptions, Inc)