



Erythrocyte, Hemoglobin and Hematocrit Profile of Bali Cattle during the Various Periods of Parturition

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Abstract | The periparturient period is a vulnerable time for cows because they have to cope with physiological, metabolic, hormonal, and various other factors related to environment stress. The blood representation in this period is very important to be observed because it can be used as an indicator of the health status in cows. This research aims to determine the profile of erythrocytes, hemoglobin levels and hematocrit values in Bali cattle during the periparturient period. Blood samples were taken from twelve Bali cattle at last three weeks of the gestation, at parturition and three weeks after parturition. The average physiological values for total erythrocytes were 5.35 ± 0.54 , 3.61 ± 0.34 and 4.46 ± 1.04 ($\times 10^6 \mu\text{l}^{-1}$); mean hemoglobin 12.11 ± 0.16 , 9.31 ± 0.66 , and 10.23 ± 2.06 g/dl and mean hematocrit 30.50 ± 2.66 , 23.83 ± 3.18 , and $25.33 \pm 2.50\%$ during prepartum, parturition and postpartum respectively. This study shows that there was a change in blood physiological parameters with normal values decreasing at last three weeks prepartum and at parturition and again increasing at three weeks postpartum.

Keywords | Bali cattle, Erythrocyte, Hemoglobin, Hematocrit, Periparturient period

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INTRODUCTION

Bali cattle (*Bos sondaicus*) is one of the local beef cattle germplasm determined as native Indonesian cattle, as stipulated in the Ministry of Agriculture Decree No: 325/Kpts/OT.140/1/2010. Bali cattle have a characteristic color of body fur which is brick red in females and in adult males the fur is blackish brown, white on the lower legs, the back of the pelvis (the buttocks) and upper-lower lip. On the back there is a black eel (longitudinal) line and also a black color at the tip of the tail (MoA, 2010). Bali cattle have a high adaptability to a limited environment and can use feed with high fiber content (Leo et al., 2012). Another advantage is high fertility and excellent conception rate (Rahayu, 2014), high percentage of carcasses and quality meat with low fat content (Nuraini et al., 2018).

The periparturient period is defined as a transition period, which starts with last three weeks of gestation to three weeks after parturition (Vargova and Kovac, 2016). During the transition period the cow's undergo physiological changes both metabolism and hormonal (Thompson et al., 2012; Lucy et al., 2014). So, it becomes vulnerable to various health problems or diseases related to environmental stress and management factors. A suboptimal immune response triggers this event and also a negative energy balance factor (Aleri et al., 2016). Livestock health in the periparturient period is very important, because it determines the success of the current production and reproductive performance of the next period (Wankhade et al., 2017). Changes in metabolism, productivity and livestock health status can be monitored through blood tests (Roland et al., 2014; Overton et al., 2017), but studies on Bali cattle

physiological parameters in the per parturient period are still very limited.

Blood comprises of red blood cells (erythrocyte), white blood cells (leucocyte), platelets and plasma. Erythrocyte function in the transport of O_2 and CO_2 play a role in regulating the pH balance of body fluids. Leucocyte have function in the immune system, while as platelets play a role in the process of hemostasis. Blood plasma functions as a transportation medium for nutrition, electrolytes, hormones, gases and proteins (Pittman, 2011; Thrall et al., 2012). Common parameters observed in blood tests include erythrocyte profile, leucocyte profile, hemoglobin, hematocrit, and erythrocyte index (Siswanto, 2011; Adam et al., 2015; Overton et al., 2017; Dewi et al., 2018; Sofyan et al., 2020). Erythrocyte index comprises Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH) and Mean Corpuscular Hemoglobin Concentration (MCHC). Previous studies mention Bali cattle have a normal average erythrocyte value of $5.2 \times 10^6 \mu l^{-1}$, hemoglobin around 8.7 g/dL, hematocrit value 29.2%, MCV 56.2fl, MCH 16.7pg and MCHC 32.9 g/dl (Siswanto, 2011).

Maintaining the health of cows during the transition period is very crucial for the success of production and reproduction in the next period. Restoration of poor physiological conditions of postpartum causes economic losses for breeder. Therefore, understanding changes in the periparturient period and the consequences that exist are very important for postpartum health management (Sundrum, 2015; Vargova and Kovac, 2016; Wankhade et al., 2017). Thus, the current study was designed to determine the profile of erythrocytes, hemoglobin levels and hematocrit values in Bali cattle during the periparturient period.

MATERIALS AND METHODS

THE ANIMALS

The study used twelve (eight-month pregnant) Bali cows which were selected by the purposive sampling method. All cattle were in good health which were only given forage and were located in community farms at Badung Regency in Bali Province, Indonesia. The protocol of experimental animals was approved by the animal ethical commission of the Faculty of Veterinary Medicine, Udayana University with approval number: 3239a/UN14.2.9/PD/2019.

COLLECTION OF BLOOD SAMPLE

Blood samples were taken three times, at last three weeks of the gestation, at parturition day and on three weeks after parturition (postpartum). Blood 3 ml was collected aseptically through the jugular vein using venoject

and collected into a blood vacuum tube containing ethylenediamine tetra-acetic acid (EDTA). The blood samples were immediately stored in a cool box containing dry ice, so that the temperature remains stable around 4 °C during transfer to the laboratory for examination.

MEASUREMENT OF ERYTHROCYTE PROFILE, HEMOGLOBIN AND HEMATOCRIT

Routine hematological examination was done using RT-7600 Auto Hematology Analyzer (Rayto Life and Analytical Sciences Co., Ltd). The parameters observed included total erythrocytes, hemoglobin levels, and hematocrit, MCV, MCH and MCHC. The steps were followed as per the protocol of Rayto RT-7600.

STATISTICAL ANALYSIS

Parametric data from the total erythrocyte count, hemoglobin, hematocrit and erythrocyte index were presented as Mean (\pm SD), and analysis was performed using one way Analysis of Variance (ANOVA) followed by Duncan's test. Variations between groups in periparturient period of $p < 0.05$ were considered to be statistically significant.

RESULTS

The results obtained regarding total erythrocytes, hemoglobin, hematocrit and erythrocytes index during the periparturient period were fluctuating, as presented in Table 1. The mean values of the parameters on prepartum, parturition and postpartum respectively are as follows for total erythrocytes: $5.35 \times 10^6 \mu l^{-1}$, $3.61 \times 10^6 \mu l^{-1}$, $4.46 \times 10^6 \mu l^{-1}$; hemoglobin 12.11 g/dL, 9.31 g/dL, 10.23 g/dL; hematocrit: 30.50%, 23.83%, 25.33%; MCV: 57.26 fl, 66.26 fl, 58.12 fl; MCH: 22.82 pg, 25.95 pg, 23.77 pg; MCHC: 39.93 g/dl, 40.45 g/dl, and 39.96 g/dl.

One-way ANOVA showed that during the periparturient period there were significant changes ($p < 0.05$) in total erythrocytes, hemoglobin and hematocrit, but there were no significant differences ($p > 0.05$) in the erythrocyte index. Duncan's test results showed a significant difference in physiological parameter values between the last three weeks of prepartum when compared with the time of parturition but showed no significant difference ($p > 0.05$) between parturition with three weeks postpartum, as well as between the three weeks postpartum period compared to the three weeks prepartum (Table 1).

DISCUSSION

The circulatory system works to pump blood throughout the body to transport what is needed by the tissues and remove waste products. In addition, the blood plays a role

Table 1: The mean profile of erythrocytes, hemoglobin, hematocrit values and erythrocytes index during the periparturient period.

Parameter*	3 weeks prepartum	Parturition day	3 weeks postpartum	Significance
Erythrocyte (x10 ⁶ µl ⁻¹)	5.35±0.54 ^a	3.61±0.34 ^b	4.46±1.04 ^{ab}	0.003
Hemoglobin (g/dL)	12.11±0.56 ^a	9.31±0.66 ^b	10.23±2.06 ^{ab}	0.005
Hematocrit (%)	30.50±2.66 ^a	23.83±3.18 ^b	25.33 ±2.50 ^{ab}	0.002
MCV (fl)	57.26±5.60 ^a	66.26±8.22 ^{ab}	58.12±8.92 ^{ab}	0.117
MCH (Pg)	22.82±2.23 ^a	25.95±2.94 ^{ab}	23.77±6.18 ^{ab}	0.431
MCHC (g/dL)	39.93±3.52 ^a	40.45±4.61 ^{ab}	39.96±7.42 ^{ab}	0.957

* MCV: Mean corpuscular volume; MCH: Mean corpuscular hemoglobin; MCHC: Mean corpuscular hemoglobin concentration
 Note: Different superscript letters in the same row show significant difference (p<0.05).

in the homeostatic and osmoregulation systems. Red blood cells (erythrocytes) have the main function of transporting oxygen from the lungs to all body tissues and transporting carbon dioxide from the tissues to be excreted through the lungs, that function is well done-out by hemoglobin (Pittman, 2011; Klein, 2013).

In the three weeks before parturition the average values for total erythrocytes, hemoglobin and hematocrit were higher than the normal values reported by Siswanto (2011) as 5.21x10⁶ µl⁻¹, 8.7 g/dL and 29.2% respectively. Thrall et al. (2012) stated that in the pregnancy phase in ruminants there is higher production of red blood cells and hemoglobin, this is to fulfill the physiological needs of livestock. Production of erythrocytes is related to oxygen demand in the body and is responded by increased release of erythropoietin in kidney tissue to stimulate the production of erythrocytes followed by increase of hemoglobin level too (Pittman, 2011; Klein, 2013). In the later stages of gestation, energy and nutritional needs increase for fetal development and maturation, udder maturation, milk production and birth preparation (Lean et al., 2013; Lucy et al., 2014; Muller et al., 2019). The birth process requires a lot of energy for the discharge of fetus and placenta. The body's metabolism becomes high because it converts glucose into energy in large amounts. The continuity of all these processes can be fulfilled by a good circulatory system (Sundrum, 2015).

At parturition, the physiological parameter values showed a significant decrease (p<0.05) for total erythrocytes, hemoglobin and hematocrit when compared with the three weeks of prepartum. This is in line with Oliveira et al. (2019) who stated that the Nellore cow's erythrogram was influenced by the reproductive stages. At farrowing the cow provides the last blood supply to the fetus, thereby reducing the volume of blood circulating in the parent body. Cows also experience bleeding and loss of body fluids. It causes a significant decrease in total erythrocytes including its components. Bleeding during giving birth can be indicated as regenerative anemia, where the body loses blood cells faster than the process of its formation (Klein, 2013). Decreased total erythrocytes simultaneously

also causes decrease in hemoglobin and hematocrit levels. Hemoglobin levels decrease in the last week of gestation, because there is a transfer a lot of iron (Fe) to the fetus for the formation of blood cells needed by the fetus. This is an indicator of decreased capacity in the transport of oxygen, nutrients and others needed by body tissues, which results in metabolic disorders (Pittman, 2011; Thrall et al., 2012; Klein, 2013). Periparturient metabolic disorders commonly reported in dairy cows and beef cattle include milk fever, downer cow syndrome, hypomagnesemia tetany, udder edema, left displaced abomasum, and ketosis (Sundrum, 2015; Overton et al., 2017).

Three weeks postpartum the mean recorded values increased from parturition. Statistical analysis showed that there was no significant difference (p>0.05) between the values of parturition compared with three weeks postpartum, and when compared between three weeks postpartum and three weeks prepartum. This shows that the increase in these parameters leads to normal conditions. Similar results were reported by Gavan et al. (2010). According to Roland et al. (2014) regeneration of erythrocytes begins after approximately 2 days after parturition and takes weeks to be fully accomplished. Recovery is a condition that should occur, because studies have found reproductive failure of exotic breed cattle that have low hematological values below normal (Yuherman et al., 2017).

Hematocrit and hemoglobin values are directly proportional to the number of erythrocytes (Adam et al., 2015). At the end of the periparturient period, the hematocrit value increases close to the normal range. This can be interpreted as a good condition for O₂ and CO₂ transport as well as maintaining blood pH stability (Thrall et al., 2012). This condition fulfills the increased metabolic needs of the cows, thereby ensuring the supply of nutrients to the mammary gland and for milk synthesis during the lactation period (Lean et al., 2013). Another factor is causing the hematocrit value to increase when cattle become dehydrated. Postpartum dehydration can be due to fluid loss during the birth process and livestock make a prolonged refusal to drink water (Thrall et al., 2012). In

this study dehydration can be ignored because the increase in hematocrit is still within the normal range. Hematocrit values affect the level of blood fluid viscosity, high or low levels impact increasing or slowing capillary blood flow and heart work (Klein, 2013).

Observation of the erythrocyte index is very important to know the size of erythrocyte and the character of hemoglobin as a basis for interpretation of the type and cause of anemia (Thrall et al., 2012). In current study, it was found that the erythrocyte index of Bali cattle in periparturient period was higher than the normal value reported by Siswanto (2011). We found the highest erythrocyte index value at parturition; however statistical analysis showed no significant difference ($p > 0.05$) during the transition time (prepartum-postpartum). MCV value will be higher during delivery because the cows transfuse a lot of blood in to fetus and also experience bleeding. While increase in MCH and MCHC values during pregnancy is related to breeders who are provided high-energy nutrient intake (Bezerra et al., 2013; Oliveira et al., 2019). High blood flow begins in the last three months of gestation until the day after delivery that result in higher MCHC values. The results of this study are in line with other workers who observed that in dairy cows no significant differences for the erythrocyte index during the per partum period was noticed. However, there was a slight decrease in MCH that showed iron deficiency in animals after giving birth (Gavan et al., 2010; Muller et al., 2019).

CONCLUSION

In this study it can be concluded that the physiological parameters of Bali cattle during the perparturient period for erythrocyte, hemoglobin and hematocrit profile experienced fluctuating changes. The normal values of these parameters at three weeks of prepartum decreased significantly on partum day and showed an increase towards normal values after three weeks postpartum. In future, more in-depth research needs to be done on the sub-clinical effects of changes in these parameters and prevention efforts.

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AUTORS CONTRIBUTION

MM and NS designed and supervised the study. AT

and WS conducted research, analyzed data and wrote manuscript. IWNFG participated in data analysis and revised the manuscript and MM completed the manuscript.

CONFLICT OF INTEREST

The authors have declared no conflict of interests.

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