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# Research Article
# Parameters of Blood Serum Profiles of Lactating Goats with Different Number of Parturitions

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## Abstract

**Background and Objective:** The reproductive ability of dairy goats can affect the sustainability of milk supplies which is influenced by the number of parturitions of does. This study aimed to understand the efficiency of the reproductive ability of dairy goats through blood serum parameters of goats with different numbers of parturitions. **Materials and Methods:** The study used lactating goats with approximate BCS of three which were kept in individual pens under the same circumstances and were divided into three groups based on the rates of parturitions. The blood serum was collected (n = 162) to study the changes in the blood serum parameters in the lactating goats, those with different numbers of parturitions. In addition, this study attended the uniformity of nutrient intake. **Results:** The blood serum parameters such as glucose, cholesterol, albumin and BUN differ significantly ($p<0.05$) and decrease if the number of parturitions increases. **Conclusion:** Regarding glucose, cholesterol, albumin, BUN, creatinine and total protein level, does with parturition one and two were best for nutrient availability to support reproductive activities. Does with parturitions of three and four were still proper to be used for breeding and lactation programs because the parameters of the blood serum profiles were still proper for reproductive activities.

Key words: Blood serum parameters, lactation, number of parturitions, tropical dairy goats, parturition, creatinine, albumin

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

## INTRODUCTION

Dairy goat is one of the potential tropical livestock that produces both milk and meat. Goat's milk is known for its good nutrient value. The production of goat's milk in Indonesia is still traditionally managed. For this reason, production and efficiency can still be developed by improving reproduction management. The number of parturitions of does is one of the important reasons for culling to meet milk production sustainability. Parturition is the delivery process of fully grown fetal through normal pregnancy period[1]. The increase in the number of parturitions can affect the nutrient status and this can reduce the does reproductive efficiency[2]. A previous study revealed that in dairy goats, estrus characteristics were affected by the increase of parturition number[3] which is speculated to be associated with the doe's hormonal changes or even changes in nutrient status.

The primary problems in reproductive efficiency are nutritional deficiencies and imbalances in energy, protein, minerals and vitamin[4]. The negative energy and protein balance following parturition and lactation is inevitable in all dairy ruminants[5]. The need for energy and protein can increase rapidly. Besides, feed consumption cannot catch up with this occurrence[5]. The negative energy balance in cows affects changes in the expression profiles of genes involved in lipid metabolism, adipose tissue metabolism and reproductive functions[6]. In a previous study on cows, fatty resources are less mobilized in primiparous cows than in the multiparous ones[7]. This occurrence can affect blood serum parameters. Albumin, cholesterol, creatinine, total protein, blood urea nitrogen, glucose and reproductive hormone can be used as indicators for reproductive efficiency of livestock[8-12]. The blood serum parameters vary depending on the changes in the reproductive phases and the physiological status of does[8,9]. However, other blood serum parameter levels are still unknown, especially in does with the high number of parturitions.

The novelty of this research lies in the effect of the number of parturitions on the parameters of blood serum profiles, especially on glucose, cholesterol, albumin, blood urea nitrogen (BUN), creatinine and total protein. Research especially about tropical lactating goats has never been conducted. Goats from tropical areas tend to have the low reproductive ability and need efficient management to make dairy goat farming profitable[13]. In addition, this study did not use any treatments and attempted to eliminate other factors to highlight the factors on the specific number of parturitions. The natural reproduction cycle was used in this research to achieve natural, green and clean methods to meet the consumer's demands[13]. This study tries to understand the culling of dairy goats based on their reproductive ability which is observed from the parameters of blood serum profiles. This way, the effectiveness and sustainability of goat milk production can be achieved in Indonesia.

This study aims to understand the efficiency of does' reproductive ability through the parameters of blood serum profiles, specifically of glucose, cholesterol, albumin, BUN, creatinine and total protein of dairy goats with a different number of parturitions. This study also aims to provide recommendations for traditional farmers regarding culling using the parameters of blood serum profiles as indicators for reproductive efficiency status.

## MATERIALS AND METHODS

This study was carried out in three farms in Turi, Sleman Regency, Yogyakarta, Indonesia (7.37°LS dan 110.22°LE). The data collection and data analyses were conducted from early July until September, 2021. The proximate feed analysis was carried out at the laboratory of Feed Technology, Faculty of Animal Science, Universitas Gadjah Mada. The preparation of serum was carried out at the Laboratory of Animal Physiology and Reproduction, Faculty of Animal Science, Universitas Gadjah Mada. The serum obtained was then analyzed in the Integrated Research and Testing Laboratory, Universitas Gadjah Mada.

**Ethical approval:** The use of animals and the blood collection procedures in this study were already approved by the Research Ethics Committee of the Faculty of Veterinary Medicine at Universitas Gadjah Mada, Yogyakarta, Indonesia (00070/ECFKH/Eks./2021).

**Experimental design:** The blood serum samples were obtained from three farms in Turi, Sleman Regency, Yogyakarta, Indonesia. Dairy goats with earlymiddle lactation were those with the approximate body condition score (BCS) of three. The total lactating does were 41 and were divided into groups based on the number of parturitions. This study tried to eliminate other factors than the number of parturitions. The parturition grouping was considered as treatment. Group 1 consisted of does with one number of parturition, group 2 with two number of parturitions and group 3 with three or four number of parturitions. All does were kept under the same circumstances in individual pens with free access to water. All does were fed with dried *Ipomoea reptans* and concentrates. This study attempted to uniform the nutrient intake of the does. The average given

nutrient values were 3.01% of dry matters (DM), 0.3% of ash, 0.44% of crude protein (CP), 0.12% of extract ether (EE), 0.88% of crude fiber (CF), 1.29% of nitrogen free extract (NFE) and about 1.61% of total digestible nutrient (TDN)[4]. The feed intake was calculated by weighing the leftover each day for a week before the blood collection. The blood samples were obtained from two different estrus cycles (in each follicular and luteal phase) with a 1 week interval between one cycle to another. This is because the parameters of blood serum profiles tend to vary based on the reproductive phases and physiological status of the does[8,9]. The blood was collected at 9 am after feeding and milk collection. The blood was taken from the jugular vein[9] approximately 9 mL inside the collecting tube with EDTA[10]. All serums were obtained from centrifugated blood using 3000 rpm for 15 min. The obtained serums were then stored[8-10] at 20°C. All serums were analyzed using reagents for the parameters of blood serum profiles (Diasys, Germany) and a Microlab 300 spectrophotometer (Merck, Germany). The parameters of blood serum profiles used in this research were albumin (bromocresol blue), cholesterol (CHODPAP), creatinine (kinetic test without deproteinize, Jaffe), total protein (biuret), blood urea nitrogen (urease GLDH) and glucose (GODPAP). The feed was analyzed using the proximate method to determine the DM, ash, CP, EE, CF, NFE and TDN values. The feed was given in a dried condition. Therefore, it was assumed that the given and the leftover feed had the same nutrient value.

**Statistical analysis:** The obtained data such as the glucose, cholesterol, albumin, BUN, creatinine and total protein level in the blood serum were analyzed using oneway ANOVA and Duncan using SPSS 25.0 software. The grouping, which is based on the number of parturitions, was considered as a treatment to know the impact of parturition on the parameters of blood serum profiles. The results were then shown as Mean±SD. The correlation between nutrients and parameters of blood serum profiles was analyzed using bivariate correlations by Pearson with onetail analysis.

## RESULTS

The values of nutrient consumption vary in does with a different number of parturitions although they were given the same nutrient. Nutrient intake from lactating does was provided in Table 1. The nutrient intake results such as DM, CP, CF and NFE were significantly different ($p<0.05$) among parturition groups. The nutrient intake results from ash, extract ether (EE) and total digestible nutrient (TDN) did not show a significant difference ($p>0.05$).

Table 1: Nutrient intake of dairy goats in different parturition groups

| Nutrient content (kg) | Group 1 | Group 2 | Group 3 |
|---|---|---|---|
| Dry matter | 2.04±0.23[a] | 1.77±0.18[b] | 2.03±0.24[a] |
| Ash | 0.24±0.03 | 0.21±0.05 | 0.23±0.03 |
| Crude protein | 0.26±0.01[a] | 0.28±0.14[b] | 0.26±0.13[a] |
| Extract ether | 0.09±0.01 | 0.10±0.01 | 0.09±0.01 |
| Crude fiber | 0.51±0.12[a] | 0.38±0.09[b] | 0.51±0.12[a] |
| Nitrogen free extract | 0.96±0.11[a] | 0.83±0.09[b] | 0.96±0.12[a] |
| Total digestible nutrient | 1.04±0.05 | 1.02±0.11 | 1.04±0.07 |

[a,b]Different superscripts in the same column show significant difference ($p<0.05$)

Table 2: Parameters of blood serum profiles in different numbers of parturitions (Mean±SD)

| Blood serum profile | Group 1 (n = 60) | Group 2 (n = 62) | Group 3 (n = 40) |
|---|---|---|---|
| Glucose (mg $dL^{-1}$) | 60.84±6.42[a] | 61.92±7.09[a] | 57.74±7.30[b] |
| Cholesterol (mg $dL^{-1}$) | 124.55±32.28[a] | 115.57±24.47[a] | 92.96±16.97[b] |
| Albumin (g $dL^{-1}$) | 3.97±0.20[b] | 3.83±0.18[a] | 3.79±0.13[a] |
| BUN (mg $dL^{-1}$) | 20.30±5.87[a] | 20.16±4.71[a] | 16.62±5.63[b] |
| Creatinine (mg $dL^{-1}$) | 0.79±0.20 | 0.84±0.19 | 0.87±0.25 |
| Total protein (g $dL^{-1}$) | 6.53±1.98 | 7.05±1.98 | 6.77±1.89 |

[a,b]Different superscripts in the same columns show a significant difference ($p<0.05$)

Dry matter consumption in Group 2 was significantly lower than that in Group 1 and 3 ($p<0.05$). The results showed that the concentrate intake in Group 2 is higher than in Group 1 and 3 resulting in a higher CP intake. Groups 1 and 3 have similar DM intake from both forages and concentrates. The comparison of DM intake between forages concentrates and total DM in the different number of parturitions was provided in Fig. 1.

The results of glucose, cholesterol, albumin and BUN levels differ significantly among the groups ($p<0.05$). however, the creatinine and total protein do not differ significantly ($p>0.05$) in different parturition groups. The glucose, cholesterol, albumin and BUN levels decrease when the number of parturitions increases. The glucose, cholesterol, albumin and BUN in Group 3 are the lowest among the groups as shown in Table 2. The significant difference ($p<0.05$) of glucose, cholesterol, albumin and bun in group 3 indicated its different reproductive ability compared to Group 1 and 2.

The glucose level showed negative correlations for DM, NFE ($p<0.05$) and creatinine ($p<0.01$) but indicated a positive correlation for CP ($p<0.05$). The cholesterol level showed a negative correlation for the number of parturitions ($p<0.01$) but a positive correlation for BUN ($p<0.05$). The albumin level showed negative correlations for the number of parturitions and CP ($p<0.01$) but positive correlations for DM ($p<0.01$) and NFE ($p<0.05$). The BUN level showed negative correlations for the number of parturitions, DM, NFE and CF ($p<0.05$) but a positive correlation for cholesterol ($p<0.05$). The creatinine level showed a negative correlation for glucose ($p<0.01$) but shows positive correlations for DM, EE ($p<0.05$), CF and NFE ($p<0.01$). The total protein level does not indicate any significant correlations ($p>0.05$) (Table 3).

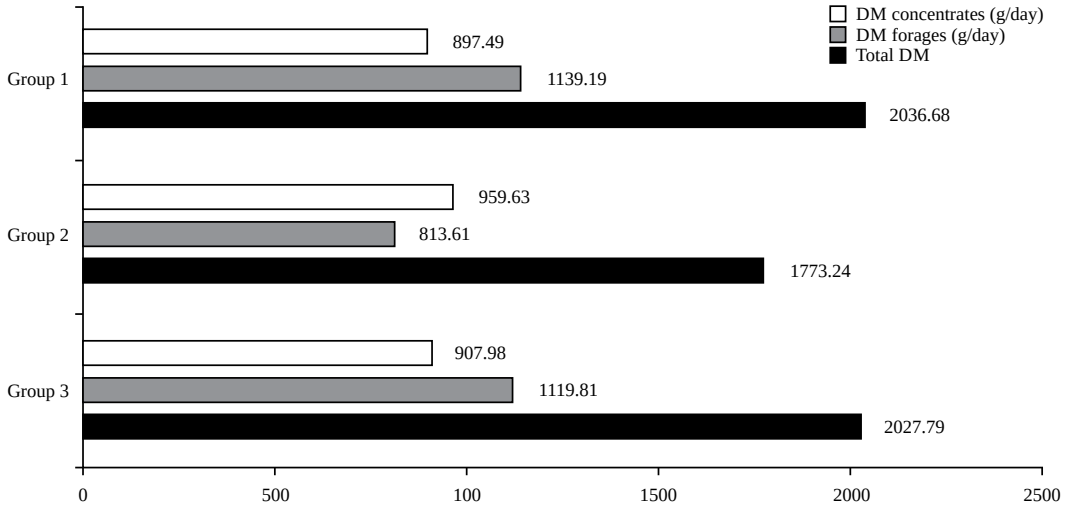


Fig. 1: Comparison of DM intake between forages, concentrates and total DM in different numbers of parturitons

Table 3: Correlations between nutrient intake and blood serum profiles in different number of parturitions

| Pearson correlation | Glucose | Cholesterol | Albumin | BUN | Creatinine | Total protein |
|---|---|---|---|---|---|---|
| Parturition | NS | -0.432** | -0.488** | -0.340* | NS | NS |
| DM | -0.313* | NS | 0.406** | -0.329* | 0.357* | NS |
| Ash | NS | NS | NS | NS | NS | NS |
| CP | 0.301* | NS | -0.441** | NS | NS | NS |
| EE | NS | NS | NS | NS | 0.296* | NS |
| CF | NS | NS | NS | -0.319* | 0.384** | NS |
| NFE | -0.283* | NS | 0.350* | -0.344* | 0.387** | NS |
| TDN | NS | NS | NS | NS | NS | NS |
| Glucose | 1 | NS | NS | NS | -0.462** | NS |
| Cholesterol | NS | 1 | NS | 0.349* | NS | NS |
| Albumin | NS | NS | 1 | NS | NS | NS |
| BUN | NS | 0.349* | NS | 1 | NS | NS |
| Creatinine | -0.462** | NS | NS | NS | 1 | NS |
| Total Protein | NS | NS | NS | NS | NS | 1 |

NS: Result shows that there is no correlation between nutrient intake and blood serum profiles (p>0.05), **Correlation shows a significant difference at 0.01 level (1tailed) and *Correlation shows a significant difference at a 0.05 level (1 tailed)

## DISCUSSION

Despite the same content in their ratio, does in different parturition groups showed different nutrient intake. This study found that Group 2 had higher concentrate intake than forage intake, therefore Group 2 had the highest CP intake compared to Group 1 and 3. Groups 1 and 3 in this study have similar nutrient intake. The high concentrate intake in Group 2 was caused by the high physiological need for growth. This was because of the usage of energy for growth which tends to decrease when the number of parturitions increases to give a better picture of nutrients distribution for milk production[14] as it is regulated by the growth hormone (GH) and insulin[15]. A previous study stated that dairy goat is considered mature and then stops growing when reaching 5 years old[15] when the puberty age of does is 5 until 7 months[16]. According to another previous study on dairy goats, feed intake was regulated by the metabolic demand[15] and milk production[14] of the does. Another previous study also reported that the requirement for protein is higher in growing ruminants[17]. Nutrient metabolism from feed intake was transported in the blood resulting in blood serum profiles. This study showed that glucose, cholesterol, albumin and BUN levels as found in Group 3 were lower than those in Group 1 and 2. The blood serum profiles vary based on the reproductive phases and physiological status[8-10] of the does and this correlates with the reproductive health[8,9]. This study indicated different reproduction abilities especially among goats in Group 3 when compared to those in Group 1 and 2.

Glucose level indicated energy consumption from feed and its metabolism[18] with the most important function as a lactose precursor[15]. All result was in the normal range according to the studies of Kacang goat[10] and Ardi goat[18]. The results showed that the glucose level among goats in Group 3 is lower than that found in Group 1 and 2. This might be because goats in Group 3 had undergone more gestation and lactation and this could be observed from the decrease in the glucose levels of the groups even when the nutrient intake on TDN does not differ significantly among groups. Also, the NFE intake in Group 3 was higher than in Group 2. The decrease in blood glucose level indicated a negative energy balance[19], especially in Group 3. According to some previous findings, the third parturition has the highest milk yield[14] which means that does in Group 3 requires higher needs of energy for maintenance, reproductive activities and lactation. A previous study reported that tropical Saanen goats with higher blood glucose levels have more efficient reproduction[8] and this correlated with the release of gonadotrophin hormone (GnRH)[10]. This situation stimulated gluconeogenesis and lipolysis as a response to endocrine changes[20]. Factors affecting glucose levels were litter size[21], milk yield[20] of does and lactation period[21].

Cholesterol is primarily synthesized in the liver as a product of lipid metabolism[18]. The results of this study showed that the decrease in the cholesterol level is in line with the increase in the number of parturitions which is similar to previous studies on Kacang goats[10] and Baladi goats[22]. The results also showed that the cholesterol level in Group 3 was found lower than that in Group 1 and 2. Cholesterol is an important precursor for all steroid syntheses[23]. Cholesterol synthesized the estrogen hormone in follicular cells and progesterone hormone in corpus luteum[24] which all correlated with reproductive ability such as estrus signs, supporting gestation and increase fertility. The findings speculated that the decrease in the cholesterol level was caused by the higher need for energy for Group 3 than for Group 1. A previous study reported that the decrease of the cholesterol level correlated with the negative energy balance, which induced more than 60% of body fat in dairy cows and also increased the mobilization of fatty acid in multiparous cows[7]. The results showed a negative correlation between the cholesterol level and the number of parturitions. Therefore, the increase in the number of parturitions would decrease the cholesterol level. The results also showed that the cholesterol level had a positive correlation with the BUN level. This indicated that the increase in cholesterol level would increase the BUN level and these findings were similar to a previous study[25]. From the results, both cholesterol and BUN were correlated and needed for reproductive performances in does in its normal range. A previous study reported that higher cholesterol and BUN out of normal range would result in obesity followed by low fertility in does[4,8].

Albumin represents 60% of total protein and shows protein metabolism[10,11] and protein availability[26]. The results of this study showed that the decrease in albumin level was in line with the increase in the number of parturitions which is similar to previous studies in sow[26] and cow[27]. Even though does in Group 3 had been found the lowest, the albumin level was found similar to the previous findings in Kacang goat[10] and Ardi goat[18]. The decrease in albumin level was speculated because of the higher usage of albumin in Group 3 than that in Group 1 and 2. The results of this study also showed a negative correlation between albumin and the number of parturitions. According to a previous study, albumin was favourable for reproductive ability, for it is used as a reservoir for steroid hormones in transitioning subsequent reproductive cycle and also has a positive correlation with the ovulation rate[26]. Therefore, a greater level of albumin indicated greater reproductive ability, especially in terms of steroid hormones. Factors affecting albumin levels are stressful events, such as muscle damage[26], protein syntheses in the liver, the need for protein and the preparation for colostrum and lactation[11,28].

Blood urea nitrogen (BUN) is an important source of protein synthesis among ruminants[28]. It is also the end product of protein metabolism in which the urea level in blood positively correlates with milk production[11]. The BUN level from all groups in this study was still within the normal range. These results were in line with the previous studies in Kacang goat[10] and Ardi goat[18]. The results of this study showed that the decrease of the BUN level correlated with the increase in the number of parturitions as indicated by the greater reproductive ability of does in Group 3. Even though a high BUN level indicated great milk production, it would disrupt the reproductive ability of does. High BUN level correlated with the disruption of uterine acidity which affected fetus implantation, reduces fertility rate and increased repeat breeding cases in ruminants[4]. The increase in BUN level correlated with negative nutrient balance[29] due to stress in lactation processes from transition gestation to lactation in dairy ruminants[30]. Higher needs for energy and protein would increase protein catabolism and obstruct ammonia conversion from microorganism to protein, where the excess would turn into blood urea[11].

In this study, the creatinine and the total protein levels in the three groups did not show any differences. Creatinine is a catabolic product of phosphocreatine stored to produce energy and originated from feed and muscle metabolism including gravid uterus muscle[8,9,20]. A previous study found that total protein level could be used as an indicator for the intensity of nitrogen metabolism to understand the nutritional status of ruminants[11]. Both the creatinine and protein levels did not show a significant difference ($p>0.05$) despite the different nutrient intake values, especially in CP. This indicated the increase in amino acid and nitrogen needs, but the level is still within the range of being adequate for reproduction. A previous study on cows showed that primiparous cows tend to have higher concentrations of components associated with protein syntheses through multiple signalling pathways[31]. The results of this study found that creatinine had a negative correlation with glucose. The major factor affecting protein metabolism was the demands from fetal placental developing tissues and milk production which vary from before and after gestation[11,21]. Another previous study showed that creatinine level was higher in single gestation than that in twin gestation, while total protein level tends to increase after parturition in both single and twin gestation of does[21].

This research showed the decrease of blood serum profiles following the increase of the number of parturitions which was similar to previous studies in tropical lactating goats. The level of blood serum profiles was different in nulliparous, primiparous and multiparous does[12]. The blood serum profiles were used to examine the next reproductive ability through the nutrient availability in the blood. The decrease in blood serum profiles reflects body metabolism which indicated negative energy and protein balance compared to the previous physiological state. The negative energy and protein balance in dairy goats are inevitable because the feed consumption cannot keep up with the nutrient needs of does[5]. It has been stated that lactation was prioritized over body growth regarding the usage of the stored nutrient[20]. In addition, the ability of does to produce milk increases until the fourth parity although the persistence of lactation would decrease. After the fourth parity, milk yield and its persistence would decrease significantly[32].

Both Group 1 and 2 had the highest levels of glucose, cholesterol, albumin and BUN levels. This indicated better reproductive performance. The blood serum profiles in Group 3 were still within a normal range[10,18,22] to support the reproductive ability of the dairy goats. Even though the glucose level in Group 3 was the lowest, the BUN remains low. A previous study in tropical Saanen goats showed that the high level of BUN resulted from the catabolized N compounds to support energy shortages[8]. In terms of glucose, cholesterol, albumin, BUN, creatinine and total protein levels, does with three and four times of parturition could still be properly used for a breeding and lactation program. The does in Group 3, thus, still had good reproductive ability because does with 2 until 5 times of parturition were 1.8 times more likely to become pregnant than primiparous goats[33]. Therefore, further studies on reproductive performance, such as estrus characteristics and its fertility were still required. However, the decrease in the parameters of blood serum profiles following the increase in the number of parturitions indicates that the reproductive ability will drop. Further studies about the number of parturitions were needed.

## CONCLUSION

The parameters of blood serum profiles were affected by the number of parturitions. The glucose, cholesterol, albumin and BUN levels decreased when the number of parturitions increased. Does with parturition one and two were best for nutrient availability to support the reproductive activities. Does parturition three and four were still proper for the breeding and lactation program because the parameters of blood serum profiles were still proper for reproductive activities.

## SIGNIFICANCE STATEMENT

This study discovered the changes in blood serum profile following the increase of parturition amount in tropical dairy goats. Blood serum profiles such as glucose, cholesterol, albumin and blood urea nitrogen can be taken into consideration for does' culling management to improve both reproduction and lactation ability, especially in local farmers. We believe that our study makes a significant contribution to the literature because of the discovery of significant changes in glucose, cholesterol, albumin and blood urea nitrogen level between groups based on different parturition amounts. This study provides evidence and support to some undiscovered assumptions in previous research. This study demonstrates that does with 1 until 2 times of parturition are best for nutrient availability to support growth and reproductive activities, even though does with parturitions of 3 until 4 are still proper to be used for breeding and lactation programs.

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