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Physiological and Biochemical Blood Indicators of Boer X Saanen Crossbred Goats Raised in Binh Duong Province, Vietnam

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ABSTRACT: This paper presents the results of a study on the physiological and biochemical blood indices of F1 (Boer x Saanen) crossbred goats raised in Binh Duong province, Vietnam. Blood samples from 160 goats were taken by venipuncture from each animal in the morning, data were collected by sex and two age groups (3-<12 months and 12-24 months). Blood physiological indices were measured using a Hemascreen 18 hematology analyzer. Blood biochemical indices were measured using an Abaxis Vetscan 2 chemistry analyzer. The results showed that the WBC, Mono and Neut indices varied according to age and sex ($P<0.05$). RBC, HGB, MCV, MCH had no statistically significant differences between ages and sexes ($P>0.05$). The average protein concentration was 64.82-81.85 g/L, with significant differences between the study groups ($P<0.05$). Statistically significant differences in mean values between age groups were investigated in the following parameters: Glucose, creatinine, AST, ALP, K, Ca, P, Cl. This study provides data on physiological and biochemical blood indices of Hybrids goats F1 (Boer x Saanen) as a basis for periodic health diagnosis of goat herds, promptly detecting health abnormalities. The data obtained can be used as reference limits related to physiological changes in livestock due to disease, nutritional deficiencies or other health-affecting factors. This is also the premise for studies on large goat herds to build a database of physiological and biochemical blood indices of goat breeds raised in Vietnam.

KEYWORDS: (Boer x Saanen), blood, hybrids goats, biochemical indicator, physiological indicator.

I. INTRODUCTION

In recent years, the demand for goat products has increased rapidly. Goat farming for meat and milk is receiving attention and development because it requires little investment, is easy to raise, creates jobs, ensures capital sources and does not compete with humans for food. According to the approved adjustment of the master plan for socio-economic development of Binh Duong province, Vietnam, the agricultural sector will shift towards reducing the proportion of crop production and increasing the proportion of livestock and agricultural services. In particular, goat farming has an important position in the local economy.

Blood physiological and biochemical indicators play a role and significance related to genetic characteristics, growth and development, breed quality, reproductive capacity, and adaptability of animals in different environmental conditions (Campora et al., 2011; David et al., 2013). Based on blood physiological data, it is possible to assess the reality, management, nutrition, health status monitoring, disease diagnosis, thereby choosing the most appropriate and best livestock system and management strategy to increase livestock productivity (Mirkena et al., 2010; Maria et al., 2018). Blood physiological variables can be used to monitor and/or assess the health, nutritional and physiological status of ruminants (Al-Eissa et al., 2012). Hematological profiles can also be used to assess the immune status of goats and they can also be an indicator of transport stress (El Nasri et al., 2016). Housing and other environmental factors have been reported to have a profound influence on the hematological profile of small ruminants (Samira et al., 2016).

Climate change directly affects animals, changing physiology, changing biological functions including physiological, hormonal, hematological and biochemical reactions, making goats resistant and able to survive in adverse environments (Bernabucci et al., 2010). Studies on blood physiological indices in goats show that malnutrition occurs in goats with long-term heat stress, reducing RBC and HGB production, leading to a decrease in RBC levels in the blood (Analía et al., 2021). When the temperature increases, goats become dehydrated, reducing plasma volume and increasing RBC concentration. Studies also suggest that seasons also

change hematological indices, with the highest RBC count in goats in the spring and the highest WBC in the summer, while HGB does not change significantly across seasons (Aleissa, 2011). The results of the study of hematological parameters in goats showed that there were differences in RBC and WBC between the two sexes, with females having higher RBC and WBC counts than males, while HGB and MHC did not differ (Ozgur et al., 2019).

The interpretation of blood biochemical profiles in animals is complicated by both the mechanisms controlling blood concentrations of different metabolites and the considerable variability due to the influence of several factors. Among these factors, the most prominent are breed, age, physiological stage, diet and animal management, and climate (Mellado et al., 2006). Blood biochemical composition has been widely used as a marker to determine the effectiveness of nutritional content and feed supplements in goats (Belewu and Ogusola, 2010). Immune status in goats has also been assessed through blood biochemical profiles (Al-Seaf and Al-Harbi, 2012). The biochemical profile of small ruminants, including goats, is influenced by diet, stress, reproductive status, age, sex, genetics, management, housing and environmental factors (Balikci et al., 2007; Olayemi et al., 2009).

The Center for Research and Development of Large Livestock Breeding in Binh Duong Province, Vietnam, is responsible for importing, domesticating and crossbreeding livestock breeds, including goats. The Boer goat is a breed of goat originating in South Africa with the outstanding characteristics of growing very quickly and producing more meat than regular goats and meat containing a lot of fat, imported into Vietnam from the US in 2002. The Saanen goat is a dairy goat breed originating from France, imported into Vietnam since 1997. Currently, the large livestock research and development center is crossbreeding these two goat breeds to create F1 hybrids (Boer x Saanen). However, to our knowledge, research on their physiological and blood biochemical indices is still limited. For the above reasons, this study was conducted to evaluate the physiological and biochemical blood indices of this hybrid goat breed. The study provides additional data on the physiological blood indices of goats, as a basis for periodic health diagnosis of goat herds, promptly detecting health abnormalities. At the same time, this is a premise for studies on a large goat herd to build a database on the physiological blood indices of goats.

II. MATERIALS AND METHODS

A. Page Layout Breeding, care and housing

Hybrids goats F1 (Boer x Saanen) were raised at the Center for Research and Development of Large Livestock Breeding, Lai Hung Commune, Ben Cat District, Binh Duong Province, Vietnam. The goats were raised semi-intensively, with a density of 2 m^2/1 goat. The barn is designed in the style of a stilt house, with a wooden floor 1m above the cement floor and a roof made of corrugated iron. The goats are fed 2 meals/day and night, including 1 breakfast (7-8AM) and 1 dinner (4-5PM), including green elephant grass, mixed bran (De Heus), leaves (binh linh, or jackfruit leaves, and soapberry). On average, each goat gets 2-4kg of grass, 0.5-0.8kg of bran, and 0.5kg of leaves/day. Dry straw is rolled up and placed on a trough for the goats to eat at night. The drinking water is clean, put in a clean trough in the barn for the goats to drink freely. The water trough is cleaned daily and the water is changed once a day. The barn is cleaned with a water spray every day, and disinfection is carried out every 2 weeks with BESTAQUAM-SR solution containing didecyl dimethyl ammonium bromide, mixed at a ratio of 1/400.

B. Sample collection and analysis of blood physiological and biochemical parameters

Randomly select 80 goats from 3 to <12 months old and 80 goats from 12-24 months old, each group has a male: female ratio of 1:1. All individuals are in good health, based on clinical observation results: eating, walking, and moving are normal; there are no abnormal signs in eating, living, and excreting activities. Goats in heat, pregnant, lactating, or sick are excluded. An information sheet is used to collect information on age, sex, breed, type of feed used, and date of sample collection. Blood samples are taken through the jugular vein at 7-8AM, before feeding, using a 3ml syringe (25Gx1 needle), taking 1.5-2ml of blood/individual. After taking blood, the sample is quickly put into an anticoagulant tube (EDTA), shaken gently, and the name and symbol of the sampled animal are recorded.

C. Analysis of some blood physiological indicators: WBC - White blood cells, Lympho, Mono, Neut; RBC - Red blood cells, HGB, HCT - Hematocrit, MCV - Mean corpuscular volume, MCH - Mean corpuscular HGB, MCHC - Mean corpuscular hemoglobin concentration, RDW-Red cell distribution width. All blood physiological parameters were performed on the fully automatic hematology analyzer Hemascreen 18 (Hospitex, ITALY).

D. Analysis of some blood biochemical indicators: Total protein (g/l), Globulin (g/l), Albumin (g/l), Glucose (mmol/l), Blood urea nitrogen-BUN (mmol/l); Creatinine (µmol/l); Aspartate transaminase-AST (U/l); Alanine amino transferase-ALT (U/l); Alkaline phosphatase-ALP (U/l), Na (mmol/l), K (mmol/l), Ca (mmol/l), P (mmol/l), Cl (mmol/l). Blood samples were centrifuged at 3,000

rpm for 10 minutes (Roto x 32®-Hettich). Serum was collected and kept at -200C until analysis. Blood biochemical parameters were measured using a chemistry analyzer (Abaxis Vetscan 2, Union City, CA, USA).

E. Data Analysis: Data was expressed as mean (Mean ± SD). Analysis of ANOVA and Post hoc test with Tukey-Kramer test to evaluate the difference between groups (P<0.05). Statistical parameters were processed by MS-Excel 2020 software.

III. RESULTS AND DISCUSSION

A. Blood physiological index of Hybrids goats F1 (Boer x Saanen)

The results of blood physiological indicators of Hybrids goats F1 (Boer x Saanen) are shown in Tables 1.

WBC of F1 (Boer x Saanen) female goats 12-24 months reached 18.67x10^9/l, higher than that of male goats (17.28x10^9/l), (P<0.05). Lympho in males (69.08x10^9/l) had a higher number than females (61.03x10^9/l) and this difference was statistically significant, while lymphocytes did not differ between the two sexes, but there were differences according to age groups. WBC of Hybrids goats F1 (Boer x Saanen) goats in both sexes and two age groups were within the reference value of Merck, (2016) of 4-13x10^9/l. This result is equivalent to male goats (13.63 x 10^9/l) and female goats (11.98 x 10^9/l) in the study of Washaya (2019), higher than goats in Salta, Argentina in the study of Analía et al. (2021). This may indicate that the WBC composition fluctuates with the age of the goat, because WBC is an important component involved in the immune system that helps the body fight harmful agents. The increase or decrease of WBC is related to the disease states of the body and when infected, the number of WBC will begin to increase (Al-Seaf and Al-Harbi, 2012).

The mean molecular weight of red blood cells in the blood (MCV) of male hybrids goats F1 (Boer x Saanen) is 32.35fl, which is significantly different from that of female goats, which is 33.04fl, and is higher than the normal range of 16-25fl determined in goats (Merck, 2016), but is equivalent to the research results in some other goat breeds (Analía et al., 2021). MCV is used to assess red blood cell size, a low MCV compared to normal can diagnose goats with microcytic anemia, often due to iron deficiency. On the contrary, if the MCV is high, the goat will have macrocytic anemia due to weak liver, vitamin B12 deficiency, folic acid deficiency. If the goat shows some unusual signs such as: bruises on the body, bleeding, pale skin, ... it may be due to unstable MVC index (Washaya, 2019).

The results in Table 1 show that the number of WBC, RDW, HGB between young hybrids goats F1 (Boer x Saanen) and adult goats has no statistically significant difference. However, the number of monocytes in young goats is 15.99%, lower than the value of 18.37% and has a statistical difference compared to adult goats (P<0.05). Monocytes often increase in the following cases: viral infection, parasitic infection, bacterial infection, cancer-related diseases, enteritis, monocytic leukemia, lymphoma, myeloma (Samira, 2016). The results of this study are also consistent with published results on blood physiological indices of Boer and Saanen goat breeds raised in Binh Duong province, Vietnam (Nguyen T. T. H. et al., 2022

Table 1. Blood physiology of Hybrids goats F1 (Boer x Saanen) according to age and sex (Mean±SD)

Parameter	3-12 months		12-24 months	
	Male (n=40)	**Female** (n=40)	**Male** (n=40)	**Female** (n=40)
WBC (10^9/l)	16.81^a±3.79	18.43^b±3.57	17.28^a±2.93	18.67^b±3.35
Lympho (10^9/l)	11.36±1.52	11.33±1.39	11.65±1.56	11.83±2.26
Mono (10^9/l)	2.93^a±0.83	3.33^b±0.91	3.16^a±1.24	3.51^b±0.62
Neut (10^9/l)	2.88^a±1.56	2.98^a±1.35	2.37^b±1.11	3.59^c±1.29
Lympho (%)	67.09^a±7.18	65.06^a±6.37	69.08^b±5.29	61.03^b±4.55
Mono (%)	15.99^a±1.96	18.37^b±2.71	17.21^b±2.37	19.53^c±2.53
Neut (%)	16.92^a±6,87	16.58^a±4,53	17.71^b±3.43	19,44^c±3.61
RBC (10^{12}/l)	2.16±0.24	2.13±0.63	1.99±0.41	2.27±0.77
HGB (g/dl)	7.68±1.07	7.03±1.52	7.06±0.76	7.01±2.01
HCT (%)	7.02^a±0.82	7.94^b±2.22	6.42^c±1.45	7.46^d±2.65
MCV (fl)	32.68±0.24	32.7±0.74	32.35±0.71	33.04±0.59
MCH (pg)	35.65±3.22	34.32±5.99	36.59±6.67	32.05±4.12
MCHC (g/dl)	109.96^a±10.42	106.57^b±21.83	114.87^a±24.46	98.27^b±14.64
RDW-SD (fl)	25.07±1.92	25.39±2.89	24.79±2.64	25.98±3.01
RDW-CV (%)	18.44±1.49	18.83±1.98	18.68±1.91	18.97±2.03

Note: Mean values with different letters in the same row are statistically different (P<0.05).

B. Blood biochemical index of Hybrids goats F1 (Boer x Saanen)

The results of blood biochemical indicators of F1 (Boer x Saanen) goats are shown in Tables 2. The total plasma protein content of Hybrids goats F1 (Boer x Saanen) according to the two sexes (male, female) and two age groups surveyed (group 3-12 months and group 12-24 months) was 73.83 g/l, 64.82 g/l, 81.85 g/l, 75.48 g/l, respectively. There was a statistical difference between the surveyed groups (Table 2). These values are within the normal range of 6.0-7.9 g/dl (Merc, 2016). This result is similar to the published results in other goat breeds, this content has a significant difference between age groups and sexes, the protein content in young goats is lower than in adult goats; male goats are higher than female goats. High serum protein concentration can be due to high grain intake, dehydration and high temperature (Mellado et al., 2006). Olayemi et al., (2009) reported that the total protein value in goat serum could be increased to 7.5 g/dl in free-range animals. Sakha et al. (2009) reported a normal protein value of 7.0 g/dl and also found significant gender differences, with total protein content in kid goats being significantly lower than that in adult goats.

Table 2 shows that the Globulin content of Hybrids goats F1 (Boer x Saanen) has a statistically significant difference between males and females, as well as between ages. However, the Albumin content has no statistical difference between age groups, between males and females. Several studies have demonstrated seasonal rhythmic changes in albumin and globulin in goats (Piccione et al., 2010). Total protein and globulin levels are significantly higher in the dry season. Differences in globulin values are related to physiological and genetic factors of animal adaptation (Belewu and Ogunsola, 2010). In goats subjected to long-term heat stress, total protein, albumin and globulin levels are reduced (Abdelatif et al., 2010). The effect of age was significant only for the amount of γ-globulin with an increase in relative quantity and a significant decrease in the albumin/globulin ratio in adult native goats (Piccione et al., 2010). In the study of (Abdelatif et al., 2009), seasonal variations were reported for albumin in the serum of Nubian goats. Albumin content ranged from 3.7 to 4.05 g/dl. These values are within the normal range of albumin for goat serum of 2.7 to 3.8 g/dl, except for the White Aardi which had a slightly high value (4.05±0.21 g/dl). A significant difference between goat breeds was found in the mean values of albumin (mean 3.42 g/dl), globulin (mean 3.06 g/dl) and urea (mean 34.5 mg/dl), while no significant difference in creatinine (mean 0.94 mg/dl) was found among Saanen, Kalahari red, Boer, Shami, crossbred and local goat breeds in Sudan (El Nasri et al., 2016).

Table 2. Blood biochemistry of Hybrids goats F1 (Boer x Saanen) according to age and sex (Mean±SD)

Parameter	3-12 months		12-24 months	
	Male (n=40)	**Female** (n=40)	**Male** (n=40)	**Female** (n=40)
Protein, g/l	73.83^{a}±5,51	64.82^{b}±6,13	81.85^{c}±5,82	75.48^{d}±5,62
Globulin, g/l	43.31^{a} ±5,12	38.73^{b}±5,63	45.41^{c}±5.47	36.83^{d}±4,16
Albumin, g/l	28.38±5.33	27.46±5.32	29.41±6.36	26.84 ±5.61
Glucose, mmol/l	4.36^{a} ±1.58	4.43^{a}±3.52	3.83^{b}±2.26	3.78^{b}±2.83
BUN, mmol/l	2.68±2.56	2.53±1.72	2.67±1.62	2.38±1.26
Creatinine, µmol/l	127.61^{a}±12.82	129.76^{a}±13.47	134.42^{b}±11.73	138.28^{b}±13.12
AST, U/l	94.75^{a}±7.28	95.29^{a}±10.81	112.55^{b}±11.59	108.93^{b}±12.43
ALT, U/l	29.18±3.22	28.36±2.92	31.04±3.28	29.24±3.36
ALP, U/l	148.81^{a}±11.52	151.63^{a}±12.26	147.38^{c}±11.62	143.62^{d}±12.83
Na, mmol/l	142.38± 6.72	141.61±6.52	145.83±7.42	144.59±8.26
K, mmol/l	4.81^{a}±1.35	4.62^{a}±1.26	5.16^{b}±1.08	5.13^{b}± 0.97
Ca, mmol/l	2.96^{a}±0.83	2.87^{a}±0.79	3.24^{b}±0.68	3.15^{b}±0.71
P, mmol/l	1.96^{a}±0.72	1.93^{a}±0.90	1.73^{b}±0.36	1.89^{b}±0.65
Cl, mmol/l	98.63^{a}±6.58	97.62^{a}±5.96	104.26^{b}±6.56	105.67^{b}±4.61

Note: Mean values with different letters in the same row are statistically different (P<0.05).

The average glucose concentration values of Hybrids goats F1 (Boer x Saanen) of the surveyed groups ranged from 3.78-4.43 mmol/l. These values are within the normal range for goats (2.78-4.44 mmol/l) (Merc, 2016). The results showed that this index was only statistically different between the two age groups but not between males and females (Table 2). Serum glucose concentration is regulated by diet and hormones; however, it can be influenced by many other factors, such as age, sex, breed and environment (Sakha et al., 2009). High blood glucose levels can be the result the use of certain medications such as steroids

or stress (Carmen et al., 2020). A study on lactating Kuwaiti Aradi goats and exotic Damascus and Barbari goats, blood samples were collected in summer, the results showed that the concentration for glucose ranged from 60.75-71.76 mg/dl (Samira et al., 2016), with an average of 48.15 mg/dl, the lowest glucose level was found in crossbred goats (44 mg/dl), with a significant difference ($P<0.05$).

BUN concentrations in the goat groups examined were within the normal range according to the reference table of Merc, (2016) (Table 2), with a statistically significant difference between males and females of the same age ($P<0.05$). This result is also consistent with studies reporting different values of BUN in other goat breeds (Piccione et al., 2010). Turner). Many reports have shown that BUN concentrations in young goats are lower than in adults without significant differences between the sexes (Piccione et al., 2010). Turner et al. (2005) reported a breed-by-diet interaction affecting BUN values in a study of three breeds of Boer, Nubian and Spanish goats. In general, lower BUN concentrations are an indication of low dietary protein levels or chronic liver disease. On the other hand, increased BUN may be a result of renal failure and dehydration (Mishra et al., 2013).

In this study, the creatinine levels of F1 goats, according to the survey groups, were 127.61; 129.76; 134.42; 138.28 µmol/l, respectively, which are within the normal range (106-168 µmol/l) for goats (MERC, 2016). Belewu and Ogunsola (2010) reported that different creatinine concentrations as a result of diets given to goats. Serum creatinine levels can be altered due to differences in energy and protein content of the feed. Solaiman et al. (2009) showed that creatinine levels in young animals increased linearly when cottonseed (*Gosspium hirs*) diets were provided to them. Furthermore, a study in goats grazing on rangeland grass showed that creatinine levels had different values depending on the type of roughage available during wet and dry grazing (Mellado et al., 2006). Creatinine levels can also increase in the serum of goats after water deprivation (Abdelatif et al., 2010). Creatinine is formed in skeletal muscle by the degradation of phosphocreatine to produce energy (Sulaiman et al., 2010). Serum creatinine concentrations have been observed to be proportional to muscle mass (Sakha et al., 2009) and this explains the higher creatinine levels recorded in males compared to females.

Alkaline phosphatase (ALP) is an enzyme produced by the liver and together with other enzymes such as aspartate aminotransferase (AST) and alanine aminotransferase (ALT), can be used as a marker of liver diseases and can also predict the health status of goats (Rumosa et al., 2012). Usually the information obtained from liver enzymes - combined with other investigations such as blood minerals, fecal egg count, physical examination and together with the medical history, provides an excellent basis for estimating the severity of disease and treatment in goats (Tibbo et al., 2008). These indices in the Hybrids goats F1 (Boer x Saanen) goat breed studied were all within normal limits (Table 2). The AST and ALP indices had significant differences between the surveyed ages ($P<0.05$), higher levels were found in males. For ALT, the differences between age groups as well as by sex were not statistically significant ($P>0.05$). This result is similar to the 103-105 IU/l reported by Elitok (2012) for adult Saanen goats in Turkey. A lower level of 63.2±6.9 IU/l was observed for West African dwarf goats in Nigeria (Opara et al., 2010). Several factors can influence the level of this enzyme, among them pregnancy, blood pH, disease and age (Rumosa et al., 2012).

The results of monitoring Ca, K, Na, P and Cl showed that all these indices were within normal limits (Merc, 2016). In particular, serum calcium concentrations in young goats were lower than in adult goats, while P content tended to be the opposite. In one study, calcium concentrations depended on breed and there was no significant difference in winter (10.3 mg/dl) and rainy season (10.35 mg/dl). However, Ca was higher in summer (10.6 mg/dl) than in other seasons. This result is similar to a previous study conducted by Aleissa (2011). A study showed that serum Cl and Ca increased in all breeds from early to late stages of lactation ($P<0.05$) (Carmen et al., 2020).

IV. CONCLUSION

Blood physiology and biochemistry tests are very important for the purposes of health assessment and diagnosis of various diseases in goats. In this study, sex and age factors affected most of the hematological parameters surveyed in Hybrids goats F1 (Boer x Saanen), however, all were within the average limits of the species. These results are reliable reference data in the periodic health diagnosis of goat herds and reference for further studies on blood physiology and biochemistry in goats. The data obtained can also be used as reference limits when evaluating related physiological and biochemical indices due to diseases, nutritional deficiencies or other health-affecting problems.

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