The Bangladesh Veterinarian (2022) 39 (1 – 2): 43 – 53

Influence of age on haematological and biochemical blood profiles of black Bengal goats (*Capra hircus*)

K Samaddar, Z Haque[1] and MM Rahman[*]
Department of Surgery and Obstetrics, Faculty of Veterinary Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

Abstract

The study was conducted to know the effects of age on haemato-biochemical profiles in Black Bengal (BB) goats. Fifty BB goats were equally divided into five groups: group A (control, 3 years), group B (>3 - 5 years), group C (2-<3 years), group D (1-<2 years) and group E (<1 year). Most of these haemato-biochemical parameters were within the normal range of reference values, except Albumin and ALP. The significantly (P<0.01) higher concentrations of RBC (17.9 ± 0.2 Million/cu mm), WBC (14.4 ± 0.3 Thousands/cu mm), Haemoglobin (9.0 ± 0.2 gm/dl) and PCV (29.9 ± 0.2%) were found in group B. The percentage of Neutrophil (35.2 ± 0.4%), Eosinophil (1.0 ± 0.0%) and Basophil (0.6 ± 0.0%) were higher in group E. Percentage of Lymphocyte (60.0 ± 0.4 %) and Monocyte (3.5 ± 0.2%) was higher in group B than other younger groups. The significantly (P<0.05 and P<0.01) higher concentration of total protein (74.7 ± 0.2g/L) and globulin (46.3 ± 0.5 g/L) respectively, were in Group B. Albumin (28.4 ± 0.2g/L) and ALT (22.3 ± 0.5 U/L) concentrations were significantly P<0.02) higher in Group E than other groups of goat. (*Bangl. vet*. 2022. Vol. 39, No. 1 - 2, 43 – 53)

Introduction

The haematological and biochemical profiles are important parameters to monitor and evaluate the health status of BB goats (Al-Eissa *et al.,* 2012) and other animals (Madan *et al.*, 2016). The profiles of small ruminants have been shown to be significantly influenced by factors including age, diet, stress, gender, and genetics (Mohammed *et al.,* 2016). Profiles can be used to measure transportation stress as well as the immune status of BB goats (Ambore *et al.,* 2009). There is considerable information about the normal parameters of BB goats, but the values vary according to age (Piccione *et al.*, 2007), environment (Arfuso *et al.*, 2016), sexual maturity and management (Sharma and Kataria, 2012).

Haematological values are widely used to determine the physiological adaptation and the systemic relationship of goats (Al-Bulushi *et al.,* 20017) and rabbits (Shah *et al.,* 2007). As there are no comprehensive reports on blood parameters in this breed of goats, this study was carried out to learn about the haematological and biochemical

[1]Department of Anatomy and Histology, Faculty of Veterinary Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
*Corresponding author**:-** E-mail**:** miznih@gmail.com
DOI: https://doi.org/10.3329/bvet.v38i1-2.69065
Received: 30 June 2023; Accepted: 20 August 2023; Published: 19 September 2023

blood profiles of BB goats in Bangladesh of different age groups, and to assist veterinarians in the selection of the best treatment for Bangladeshi BB goats.

Materials and Methods

Ethical approval

The study was carried out with the approval and compliance of the Animal Experimental and Ethics Committee (AEEC) of Veterinary Science at Bangladesh Agricultural University (BAU), Mymensingh (AWEEC/BAU/2019(54) on 26 December 2019).

Selection of goats

Fifty BB goats of various ages were randomly selected from the local market in Mymensingh Sadar, Bangladesh. Animals were equally distributed into five groups:
Group A: 3 years old, body weight 25-30 kg and used as control for standard data without any surgical intervention;

Group B: >3 to 5 years old, body weight 30-35 kg;
Group C: 2 to <3 years old, body weight 20-25 kg;
Group D: 1 to <2 years old, body weight 10-15 kg and
Group E: Less than 1-year-old, body weight 8-10 kg.

The goats were allowed to graze on pasture approximately eight hours daily along with 300 gm hand-formulated concentrates per head per day supplied in two splits, and were allowed clean drinking water *ad libitum.*

The goats were dewormed with anthelmintic, Endex®vet (Triclabendazole 900 mg + Levamisole 600 mg), Novartis Bangladesh Limited. Doses: 19.5 mg per kg body (1 bolus per 41-75 kg body weight). For external parasites goats were dewormed with A-Mectin Plus Vet® injection (Ivermectin BP 10 mg & Clorsulon USP 100 mg, The ACME Laboratories Ltd, Dhaka, Bangladesh, doses: 1 ml per 50 kg body weight in a single dose) every four months. Goats were vaccinated against Tetanus (Tetanus Vaccine®, Dano Vaccine and Biologicals Pvt. Ltd, India) and *Peste Des Petis Ruminants* (PPR-Vac®, Livestock Research Institute, Mohakhali, Dhaka, Bangladesh) following acclimatization for 2-3 weeks.

Sample collection

Ten millilitres of blood were collected by jugular venipuncture, separated and kept in two tubes, one of with EDTA for haematology and the other SS (serum separator) tubes (Guangzhou Improve Medical, China) for biochemistry. A cooling box was used for transportation of blood samples.

Haematological analysis

Blood for haematology was prepared with a blood lysing buffer approved for use with goats' blood (Concentrated Lysing Reagent, SEAC, Florence, Italy). The RBC, WBC, haemoglobin, Differential Leukocyte Count (DLC), volume MCV and PCV were determined within 45 minutes of sample collection using the CELL-DYN 3700 analyser (Abbott Diagnostics).

Serum biochemical analysis

The serum was extracted and kept frozen at -20°C. A Vet Scan VS2 analyser (ABAXIS, USA) measured total protein, albumin, globulin, blood urea, phosphorus, creatinine, ALT, ALP, AST and GGT.

Statistical analysis

All parameters were expressed as Mean ± SEM (Standard Error of Mean). To compare data between the groups, independent sample *t*-test was performed using Statistical Package for the Social Science (SPSS) version 20.0. The effects of age on biochemical parameters and haematology and immunological profiles of Black Bengal goats were analysed by one-way analysis of variance (ANOVA). Probability $P<0.05$ and $P<0.01$ was considered as statistically significant and highly significant respectively.

Results and Discussion

Standard haematological parameters in BB goats

The haematological parameters of BB goats (control group A) are presented in Table 1. The results were determined as mean ± SE with their reference values.

Table 1: Haematological parameters of BB goats (control group A) (Mean ± SE) in Bangladesh

Parameters	Concentrations	Reference values* (Physiological value)
RBC (Million/cu mm)	16.6 ± 0.4	8 - 18
Haemoglobin (gm/dl)	6.9 ± 0.3	8 - 12
WBC (Thousand/cu mm)	12.3 ± 0.4	3 - 13
Neutrophil (%)	35.6 ± 0.8	30 - 48
Lymphocytes (%)	58.9 ± 0.8	50 - 70
Monocytes (%)	3.3 ± 0.2	0 - 4
Eosinophil (%)	1.3 ± 0.2	1 - 8
Basophil (%)	0.9 ± 0.2	0 - 1
MCV (U/L)	30.2 ± 0.5	33 - 39
PCV (%)	27.7 ± 0.4	24.5 - 30.4

PCV = Packed Cell Volume; Hb = Haemoglobin; RBC = Red Blood Cell; WBC = White Blood Cells; MCV = Mean Corpuscular Volume; *According to Feldman *et al.* (2002), (Schalm's Veterinary Hematology. Philadelphia. Baltimore, New York, London, Buenos Aires, Hong Kong, Sidney, Tokyo: Lippincott Williams and Wilkins).

In BB goats (control group A) total RBC, haemoglobin, total WBC, Neutrophils, Lymphocyte, Monocytes, Eosinophil, Basophil, MCV and PCV were within reference values (Feldman *et al.,* 2002) and are presented in Table 1.

This result was supported by the previous studies of Bulushi *et al.* (2017) and Shaikat *et al.* (2013).

Haematological parameters of BB goats according to age

The age-related haematological parameters are presented in Table 2. RBC, WBC, Haemoglobin and PCV in group B were significantly (P<0.01) higher than in other groups. There was no significant (P>0.05) difference in Neutrophils, Lymphocytes, Monocytes and MCV between the age groups. Eosinophils and basophils in group E were significantly (P<0.05) higher than in group B but there was no significant difference between B, C and D or C, D and E (Table 2).

Table 2: Haematological properties of BB goats according to age in Bangladesh (Mean ± SE)

Parameters	Concentrations					P values	Level of Signifi-cance
	Group B (3 to 5 Years)	Group C (2 to 3 years)	Group D (1 to 2 years)	Group E (<1 year)	Normal Ranges/ Reference values*		
RBC (million/cu mm)	17.9 ± 0.2^{a}	15.8 ± 0.2^{b}	12.9 ± 0.2^{c}	11.7 ± 0.2^{c}	8 - 18	0.000	**
WBC (thousand/cu mm)	14.4 ± 0.3^{a}	12.1 ± 0.2^{b}	9.4 ± 0.2^{c}	6.8 ± 0.2^{d}	8 - 12	0.000	**
Haemoglobin (gm/dl)	9.0 ± 0.2^{a}	6.1 ± 0.2^{b}	6.6 ± 0.2^{b}	5.4 ± 0.7^{b}	3 - 13	0.008	**
Neutrophil (%)	35.2 ± 0.4	35.8 ± 0.6	37.6 ± 0.6	39.6 ± 0.9	30 - 48	0.363	NS
Lymphocytes (%)	60.0 ± 0.4	59.1 ± 0.4	57.4 ± 0.6	54.2 ± 0.9	50 - 70	0.113	NS
Monocytes (%)	3.5 ± 0.2	3.2 ± 0.3	3.13 ± 0.3	3.1 ± 0.3	0 - 4	0.995	NS
Eosinophil (%)	1.0 ± 0.0^{c}	1.3 ± 0.1^{bc}	1.3 ± 0.1^{bc}	2.1 ± 0.2^{ab}	1 - 8	0.029	*
Basophil (%)	0.6 ± 0.0^{c}	0.6 ± 0.1^{abc}	0.5 ± 0.1^{bc}	0.8 ± 0.1^{ab}	0 - 1	0.024	*
MCV (U/L)	30.9 ± 0.4^{a}	29.6 ± 0.4^{ab}	28.5 ± 0.3^{ab}	27.3 ± 0.4^{b}	33 - 39	0.142	NS
PCV (%)	29.9 ± 0.2^{a}	28.6 ± 0.3^{ab}	24.5 ± 0.2^{c}	24.0 ± 0.2^{c}	24.5 - 30.4	0.000	**

Different superscript letters in the same row differ significantly and a>b>c. NS = Not significant (P>0.05), * = Significant at 5% level of probability (P< 0.05), ** = Significant at 1% level of probability (P<0.01). PCV = Packed Cell Volume; Hb = Haemoglobin; RBC = Red Blood Cell; WBC = White Blood Cells; MCV = Mean Corpuscular Volume; MCH = Mean Corpuscular Haemoglobin; MCHC = Mean Corpuscular Haemoglobin Concentration; *According to Feldman *et al.* (2002).

The BB goats of 3 - 5 years of age (group B) had a significantly higher concentration of RBC (17.9±0.2 million/cu mm) than in the BB goats of less than 1 year (group E), which had the lowest concentration of RBC (11.7±0.2 million/cu mm). These findings back those by Shaikat *et al.* (2013) and Zumbo *et al.* (2011). The RBC count was higher than that of Piccione *et al.* (2010) findings. The age differences are due to maturation in

lymphoid system (Pomoroksa-Mol *et al.,* 2020). Lower RBC counts in younger goats may be accompanied by deficiency of some vitamins and iron (Bulushi *et al.,* 2017).

Shaikat *et al*. (2013) concurred with the present findings of haemoglobin content, but Piccione *et al*. (2010) found a higher Hb content in their studies. In the current study, the haemoglobin concentration was lower than the result obtained for Kano and Borno goats (Njidda *et al*., 2013). The haemoglobin concentration in group B was significantly higher than other groups and this is consistent with the study of Njidda *et al*. (2013). Adult goats' blood had a higher oxygen-carrying capacity (Njidda *et al*., 2013).

In adult goats total WBC counts were within the normal ranges as indicated by Feldman *et al.* (2002) and Mohammed *et al.* (2016), though the values were lower than Bulushi *et al.* (2017) and higher than Tambuwal *et al.* (2002). The total WBC counts in adult goats were higher than in younger ones, which are supported by the study of Mohammed *et al.* (2016). The higher values of WBC in adult goats suggest a stronger immunity in adult goats (Njidda *et al.,* 2013). In the current study, younger goats had fewer WBC than those in Zumbo *et al.* (2011) and this may be due to geographical variations.

The result showed higher lymphocytes count in adult goats, but higher neutrophils count in younger goats. Similar findings were observed by Pradhan (2016). The monocyte percentage agreed well with the study by Njidda *et al.* (2013). The monocyte percentage was lower than that of Shaikat *et al.* (2013) in adult goats and greater than that of Piccione *et al.* (2010) and these may be due to geographical variations. The monocyte percentage was higher in group B than in other groups, as supported by Njidda *et al.* (2013). The Eosinophil and Basophil percentages agreed with the findings of Bulushi *et al.* (2017). The eosinophil and basophil counts were higher in group E than in other groups and were supported by Pradhan (2016).

The study demonstrated considerably greater levels of MCV in older goats (group B) compared to younger ones. These findings are backed by Shaikat *et al.* (2013) but disagree with the study of Elitok (2012). The MCV value of the current investigation was significantly greater than that of Zumbo *et al.* (2011) who used Messinese goat kids and their dams. This variation may be due to breed and geographical variation. The values of MCV considerably increased, while decreased in MCHC, indicated macrocytic and hypochromic anaemia (Barger, 2003), it means that the goats in Berger's study were suffering from anaemia. PCV values were similar to the findings of Azab and Abdal-Maksoud (1999), but higher than that of Tambuwal *et al.* (2002). The highest PCV content was observed in group B, and this was supported by research of Shaikat *et al.,* (2013). Higher PCV values can occur due to high ambient temperature (Isidahomen *et al.,* 2010) or a decrease in the volume of plasma (Njida *et al.,* 2013).

Standard biochemical parameters in BB goats in Bangladesh

The values of biochemical parameters of BB goats (control group A) are presented in Table 3. The results were determined as mean ± SE with their reference values.

Most of the parameters were within the normal reference values. Only Albumin and ALP were slightly lower. All the parameters except Albumin and ALT were within the ranges described by Feldman *et al.* (2002) and Mohammed *et al.* (2016). These results agreed with the findings of Blushi *et al.* (2017).

Table 3: Biochemical parameters of BB goats (control group A) in Bangladesh (Mean ± SE)

Parameters	Concentrations	Reference values*
Total protein (g/L)	72.7 ± 0.5	54.5 - 74
Albumin (g/L)	30.2 ± 0.6	40.4 - 61.4
Globulin (g/L)	42.5 ± 0.5	22.7 - 60
Phosphorus (mg/dl)	3.0 ± 0.1	2 - 5.1
Urea (mg/dl)	32.0 ± 0.4	21.1 - 48.4
Creatinine (mg/dl)	0.8 ± 0.0	0 - 1
ALT (IU/L)	20.9 ± 0.3	12.8 - 39.7, 20 - 360[1]
ALP (IU/L)	92.1 ± 0.4	20 - 360[1]
AST (IU/L)	114.8 ± 0.5	93 - 387
GGT (IU/L)	37.5 ± 0.9	80 - 170[1]

ALT = Alanine aminotransferase, ALP = Alkaline phosphatase, GGT = Gamma-glutamyl transferase, AST = Aspartate aminotransferase. *According to Feldman *et al.* (2002), (Schalm's Veterinary Hematology. Philadelphia. Baltimore, New York, London, Buenos Aires, Hong Kong, Sidney), Tokyo: Lippincott Williams and Wilkins. [1]Kiran *et al.*, 2012

Biochemical parameters of BB goats according to age in Bangladesh

The biochemical parameters of BB goats of different ages are shown in Table 4. The concentration of total protein in groups B, C and D was significantly ($P<0.05$) higher than in group E but there was no significant difference between the groups B, C and D. The concentrations of Urea and AST were significantly ($P<0.05$) higher in group B than in other groups.

The concentrations of Albumin (37.2 ± 0.7 g/L) and ALT (29.7 ± 0.6 U/L) were significantly higher in group E at 1% and 5% level of probability, respectively, than in other groups. The concentrations of Globulin (46.3 ± 0.5 g/L) were significantly ($P<0.01$) higher in group B than other groups. There was no significant difference in the phosphorus concentrations of the different groups. The creatinine concentration in group B, C and D was significantly ($P<0.01$) higher than group E (Table 4).

The total protein content was comparable to that of Pradhan *et al.* (2016), but greater than that of Mohammed *et al.* (2016). However, a higher protein concentration has

been reported by Elitok (2012). These are caused by high grain intake, dehydration, and exposure to high temperatures (Zubcic, 2001).

The highest protein concentration was in group B and the lowest in group E, which is supported by Elitok (2012). Serum proteins vary with goats' age (Kaneko *et al.*, 1997). The concentrations of serum albumin and globulin were in agreement with the results of Pradhan, (2016) but higher albumin and globulin concentrations were found by Khan *et al.* (2016) and lower serum albumin was found by Daramola *et al.* (2005). Low albumin caused by dehydration and retinol deficiency (Njidda *et al.*, 2013). The albumin values were found higher in group E (<1 year) and the lowest concentration was in group B (>3 to 5 years). This result is supported by Greenblatt (1979) who reported the reduced serum albumin concentration in the elderly patient. The globulin concentration was higher in adult goats and lower in young goats. This result supports a study of Elitok (2012). Albumin values decreased progressively with the advancement of age (Myer and Ehrich, 1992) due to elevated blood osmotic pressure, as because increased osmotic pressure of the blood signals the liver to reduce albumin production (Myer and Ehrich., 1992).

Table 4: Biochemical blood parameters of various age groups of BB goats in Bangladesh (Mean ± SE)

Parameters	Concentrations					P values	Level of significant
	Group B (3 to 5 years)	Group C (2-3 years)	Group D (1-2 years)	Group E (< 1 year)	Reference values		
Total protein (g/L)	74.7 ± 0.5^{a}	72.0 ± 0.9^{ab}	68.7 ± 0.7^{bc}	64.5 ± 0.4^{d}	54.5-74.0	0.002	**
Albumins (g/L)	28.4 ± 0.2^{c}	31.3 ± 0.5^{bc}	32.4 ± 0.4^{b}	37.2 ± 0.7^{a}	40.4-61.4	0.002	**
Globulins (g/L)	46.9 ± 0.5^{a}	40.8 ± 0.7^{b}	36.3 ± 0.3^{c}	27.3 ± 0.9^{d}	22.7-60.0	0.000	**
Phosphorus (mg/dl)	3.1 ± 0.2	2.7 ± 0.1	2.4 ± 0.2	2.1 ± 0.2	02-5.1	0.267	NS
Urea (mg/dl)	32.4 ± 0.4^{a}	23.8 ± 0.3^{b}	21.0 ± 0.2^{c}	18.8 ± 0.3^{c}	21.1-5.4	0.000	*
Creatinine (mg/dl)	0.8 ± 0.0^{a}	0.8 ± 0.1^{ab}	0.8 ± 0.0^{b}	0.7 ± 0.1^{c}	0-1	0.000	*
ALT (U/L)	22.3 ± 0.5^{bc}	23.7 ± 0.4^{bc}	25.3 ± 0.5^{b}	29.8 ± 0.6^{a}	12.8-4.7, 20-360[1]	0.001	*
ALP (U/L)	95.5 ± 0.5^{bc}	97.0 ± 0.7^{abc}	98.3 ± 0.7^{ab}	101.3 ± 1.1^{a}	20-360[1]	0.025	*
AST (U/L)	116.2 ± 0.4^{a}	101.5 ± 1.1^{b}	91.8 ± 1.3^{c}	78.5 ± 1.9^{d}	93-387	0.000	*
GGT (U/L)	40.9 ± 1.0^{a}	38.0 ± 0.7^{ab}	36.9 ± 0.9^{ab}	33.4 ± 0.9^{b}	80 – 170[1]	0.232	**

Different superscript letters in the same row differ significantly and a>b>c. NS = Not significant (P>0.05), * = Significant at 5% level of probability (P<0.05), ** = Significant at 1% level of probability (P<0.01). ALT=Alanine Aminotransferase, ALP = Alkaline Phosphatase, AST = Aspartate Aminotransferase; GGT = Gamma-glutamyl transferase.

The phosphorous content was less than that of Rice and Hall (2007). The urea concentration was in agreement with Elitok (2012) but lower than Shaikat *et al.* (2013).

Urea concentrations were significantly higher in group B than in other groups. This supports Shaikat *et al.* (2013), but was different from the findings of Elitok (2012).

The increased serum urea level could be related to excessive tissue protein catabolism caused by protein deficiency (Njidda *et al.,* 2013). Serum creatinine was lower than reported by Mohammed *et al.* (2016). The creatinine concentration was higher in the adults than in the young goats. Similar findings were obtained in the study of Elitok (2012). Creatinine levels in blood serum may be affected by variations in feed energy and protein (Mohammed *et al.,* 2016) and may be associated with protein metabolism due to their large muscle mass in adult animals (Myer and Ehrich, 1992).

The mean values of serum enzyme activity of ALT, AST, ALP, and GGT in goats were within the normal ranges cited by Feldman *et al.* (2002) and Kiran *et al.* (2012). The average values of ALP were higher than those of Daramola *et al.* (2005) and lower than those of Bulushi *et al.* (2017). This could be due to variations in blood pH and diseases (Kelly, 1974). Serum GGT values were within the reference range of Latimer (2011) but slightly lower than Bulushi *et al.* (2017). The higher values of ALT and ALP were in younger goats than in adults, as supported by Pradhan (2016). It may be due to more extreme bone remodelling and enzyme spills from developing bones and intestines into the blood (Elitok *et al*., 2004). Serum AST and GGT levels were higher in adult goats than in the younger ones. The same findings were observed in Bhat *et al.* (2014). These variations are used as predictors of physical stress and hepatocellular injury (Temizel *et al.*, 2009).

Conclusions

It is concluded that the age of the BB goats had a significant impact on the biochemical and haematological indices. Result of this study will assist better understanding of age-related haematological and biochemical indices for clinical management of BB goats. Further study will be required to confirm the values based on gender, seasons, and other environmental factors.

Conflict of interest

The authors affirm that there are no conflicts of interest.

Acknowledgements

The authors would like to thank the all the teachers, stuffs, students and laboratories of department of surgery and obstetrics, as well as the Veterinary Teaching Hospital, BAU, Mymensingh-2202, Department of Physiology and the Central Laboratory, BAU, Mymensingh, for their laboratory support and the University Grant Commission (UGC), Bangladesh, Dhaka for financial assistance.

References

AL-Eissa MS, Alkahtani S, Al-Farraj SA, Alarifi SA, Al-Dahmash B, Al-Yahy H 2012: Seasonal variation effects on the composition of blood in Nubian ibex (*Capra nubiana*) in Saudi Arabia. *African Journal of Biotechnology* **11** 1283-1286. DOI: 10.5897/ AJB11.2004.

Al-Bulushi S, Shawaf T, Al-Hasani A 2017: Some hematological and biochemical parameters of different goat breeds in Sultanate of Oman "A preliminary study". *Veterinary World* (April) **10** 461-466. doi: 10.14202/vetworld.2017.

Ambore B, Ravikanth K, Maini S, Rekhe DS 2009: Haematological profile and growth performance of goats under transportation stress. *Veterinary World* **2** 195-198. DOI: 10.5455/vetworld.2009.195-198.

Arfuso F, Fazio F, Rizzo M, Marafioti S, Zanghì E, Piccione G 2016: Factors affecting the hematological parameters in different goat breeds from Italy. *Annals of Animal Science* **16** 743–757. DOI: https://doi.org/10.1515/aoas-2015-0094.

Azab ME, Abdal-Maksoud HA 1999: Changes in some Haematological and biochemical parameters during pre-partum and post-partum periods in female Baladi goats. *Small Ruminant Research* **34** 77-85. https://doi.org/10.1016/S0921-4488(99)00049-8

Barger AM 2003: The complete blood cell count: A powerful diagnostic tool. *The Veterinary clinics of North America: Small Animal Practice* **33** 1207-1222. DOI: 10.1016/s0195-5616(03)00100-1. PMID: 14664195.

Bhat SA, Mir MR, Reshi AA, Ahmad SB, Husain I, Bashir S, Khan HM 2014: Impact of age and gender on some blood biochemical parameters of apparently healthy small ruminants of sheep and goats in Kashmir valley India. *International Journal of Agricultural Sciences and Veterinary Medicine* **2** 22-27.

Bulushi SA, Shawaf T, Hasani AA 2017: Some hematological and biochemical parameters of different goat breeds in Sultanate of Oman "A preliminary study". *Veterinary World* **10** 461–466. DOI: 10.14202/vetworld.2017.461-466.

Daramola JO, Adeloye AA, Fatoba TA, Soladoye AO 2005: Haematological and biochemical parameters of West African Dwarf goats. *Livestock Research for Rural Development* **17** 95.

Elitok B 2012: Reference Values for Hematological and Biochemical Parameters in Saanen Goats Breeding in Afyonkarahisar Province. *Kocatepe Veterinary Journal* **5** 7–11.

Elitok B, Elitok OM, Gundogan M 2004: Hematological and Biochemical Reference Values of Various Age and Sex in Anatolian Water Buffaloes (*Bubalus bubalus*). *Hayvancilik Arastirma Dergisi* **14** 85-90.

Feldman B, Zink J, Jain N,2002: *Schalm's Veterinary Hematology.* Philadelphia, PA, Baltimore, New York, London, Buenos Aires, Hong Kong, Sidney, Tokyo: Lippincott Williams and Wilkins.

Greenblatt DJ 1979: Reduced serum albumin concentration in the elderly: a report from the Boston Collaborative Drug Surveillance Program. *Journal of the American Geriatrics Society* (January) **27** 20-22. DOI: 10.1111/j.1532-5415.1979.tb01715.x. PMID: 759470.

Isidahomen EC, Ikhimioya I, Njidda AA, Okoruwa MI 2010: Haematological parameters and Blood chemistry of different species of Ruminant animals in Humid Tropical environment. *Nigerian Journal of Agriculture and Forestry* **3** 85-90.

Ismail, ZAB, Al-Majali, AM, Amireh F, Al-Rawashdeh OF 2008: Metabolic profile in goat does in late pregnancy with and without subclinical pregnancy toxemia. *Veterinary Clinical Pathology* **37** 434–437. DOI: 10.1111/j.1939-165X.2008.00076.x.

Kaneko JJ, Harvey JW, Bruss ML 1997: *Blood analytic reference values in large animals.* Clinical biochemistry of domestic animals, Fifth edition, Delhi. India.

Kelly W 1974: *Veterinary Clinical Diagnosis.* Macmillan Publisher, London.

Khan KMH, Ali MK, Abdullah MM, Amin SAH 2016: Reference values for hemato-biochemical parameters in the Maraz goats. *Research Opinions in Animal and Veterinary Sciences* **6** 74-77. DOI: 10.20490/ROAVS/16-012.

Kiran S, Bhutta AM, Khan BA, Durrani S, Ali M, Ali M, Iqbal F 2012: Effect of age and gender on some blood biochemical parameters of apparently healthy small and ruminants from southern Punjab in Pakistan. *Asian Pacific Journal of Tropical Biomedicine* **2** 304-306. DOI: 10.1016/S2221-1691(12)60028-8.

Latimer K 2011: *Duncan and Prasse's Veterinary Laboratory Medicine:* In: Clinical Pathology. Wiley-Blackwell, Ames, IA. pp. 14.

Madan J, Sindhu S, Gupta M, Kumar S 2016: Hemato-biochemical profile and mineral status in growing Beetal goat kids. *Journal of Cell Tissue Research* **16** 5517–5522.

Mohammed S, Razzaque MA, Omar A, Albert S, Al-Gallaf W 2016: Biochemical and hematological profile of different breeds of goat maintained under intensive production system. *African Journal of Biotechnology* **15** 1253–1257. DOI: 10.5897/AJB2016.15362

Myer DJ, Ehrich DJ 1992: *Veterinary 1aboratory Medicine Interpretation and Diagnosis.* Philadelphia: WB Saunders Co., USA.

Njidda AA, Hassan IT, Olatunji EA 2013: Haematological and biochemical parameters of goats of semi-arid environment fed on natural grazing rangeland of northern Nigeria. *IOSR Journal of Agriculture and Veterinary Science* **3** 1-8. DOI: 10.9790/2380-0320108.

Piccione G, Borruso M, Fazio F, Giannetto C, Caola G 2007: Physiological parameters in lambs during the first 30 days postpartum. *Small Ruminant Research* **72** 57–60. https://doi.org/10.1016/j.smallrumres.2006.04.002.

Piccione G, Casella S, Lutri L, Vazzana I, Ferrantelli V, Caola G 2010: Reference values for some haematological, haematochemical and electrophoretic parameters in the Girgentana goat. *Turkish Journal of Animal Science* **34** 197-204. DOI: 10.3906/vet-0902-1.

Pomorska-Mól M, Krzysiak MK, Larska M, Włodarek J 2020: The First Report of Immunoglobulin G, M, and A Concentrations in Serum of European Bison and Their Changes with Age. *Journal of Immunology Research* **26** 14317.

Pradhan BC 2016: Evaluation of haematological and biochemical parameters of goats of central Odisha environment fed on natural grazing land of Odisha, India. *The Pharma Innovation Journal* **5** 83-90.

Rice CG, Hall B 2007: Hematologic and Biochemical Reference Intervals for Mountain Goats (*Oreamnos americanus*): Effects of capture conditions. *Northwest Science* **81** 206-214. DOI: 10.3955/0029-344X-81.3.206.

Shah MK, Khan A, Rizvi F, Siddique M, Rehman SU 2007: Effect of cypermethrin on clinico-haematological parameters in rabbits. *Pakistan Veterinary Journal* **27** 171–175.

Shaikat AH, Hassan MM, Khan SA, Islam MN, Hoque MA, Bari MS, Hossain ME 2013: Haemato-biochemical profiles of indigenous goats (*Capra hircus*) at Chittagong, Bangladesh. *Veterinary World* **6** 789-793. doi: 10.14202.

Sharma AK, Kataria N 2012: Influence of season on some serum metabolites of Marwari goats. *Indian Journal of Small Ruminant* **18** 52–55.

Tambuwal F, Agaie B, Bangana A 2002: *Haematological and Biochemical Values of Apparently Healthy Red Sokoto Goats.* Proceedings of the 27 Annual Conference of the Nigerian Society for Animal Production (NSAP). Federal University of Technology, Akure, Nigeria. pp. 50-53.

Temizel EM, Senturk SE, Kasap SE 2009: Clinical, haematological and biochemical findings in Saanen goat kids with naturally occurring heat stroke. Tierärztliche Praxis Ausgabe G: *Großtiere/Nutztiere* **37** 236-241. DOI: 10.1055/s-0038-1623961.

Zubcic D 2001: Some biochemical parameters in the blood of grazing German improved Fawn goats from Istria, Croatia. *Veterinarski Arhiv* **71** 237-244. https://hrcak.srce.hr/89348.

Zumbo A, Sciano S, Messina V, Casella S, Rosa R, Piccione G 2011: Haematological profile of Messinese goat kids and their dams during the first month post- partum. *Animal Science Papers and Reports* **29** 223- 230.