Macedonian Journal of Animal Science, Vol. **13**, No. 1–2, pp. 5–12 (2024)
Article 292
In print: ISSN 1857 – 6907
Received: August 8, 2024
On line: ISSN 1857 – 7709
Accepted: September 27, 2024
UDC: 636.39.082.455.09:616.15
https://www.doi.org/10.54865/mjas24131-2005к

Original scientific paper

EFFECT OF PREGNANCY STAGES AND POST-KIDDING ON HEMATOLOGICAL AND BLOOD BIOCHEMICAL PROFILE OF SAANEN GOATS

Hayatullah Khan[1], Ihsan Ud Din[1], Nikola Adamov[3], Sohail Khan[1], Fahad Ullah[2], Mujahid[2], Nadar Khan[1*]

[1]*Goat Production Research Station, Swat, Livestock and Dairy Development Department (Research), Khyber Pakhtunkhwa, Pakistan*
[2]*Veterinary Research Institute Peshawar, Livestock and Dairy Development (Research) Department, Khyber, Pakhtunkhwa, Pakistan*
[3]*Ss. Cyril and Methodius University in Skopje, Faculty of Veterinary Medicine, Department of Animal Breeding and Husbandry, Skopje, North Macedonia*
*Nadar73vet@aup.edu.pk

A b s t r a c t: The present study aimed to determine how the hematological and biochemical profiles in Saanen goats were affected by the various stages of pregnancy and the post-kidding period at the Goat Production Research Station Charbagh, Swat. A total of 30 Saanen female goats aged 2–4 years with an average body weight of 40±2.5 kg were randomly selected for the study. The blood samples were collected from non-pregnant goats at day 0, 45th, 90th, and 135th days of pregnancy, and after 30 days of kidding (180th day; lactation stage) for hematological analysis (WBC, RBC, Hb, PCV, MCV, MCH, and MCHC) and biochemical analysis (ALP, ALT, AST, albumin, glucose, calcium, urea, and creatinine). The results showed that non-pregnancy, pregnant stages, and post-kidding significantly affected WBC, RBC, Hb, MCH, and MCHC, whereas PCV and MCV showed no significant difference. The WBC level significantly increased to 14.28±0.25·10^3/µl on the 135th day of pregnancy. The total RBC count was higher (11.44±0.15·10^6/µl) in the non-pregnant stage and decreased significantly ($P < 0.05$) in late pregnancy to 9.22 ±0.066·10^6/µl. Similarly, Hb levels significantly increased (10.12±0.107 g/dl) during the last stage of pregnancy. MCH and MCHC levels decreased with advanced pregnancy and post-kidding. ALT was affected after 90 days of pregnancy, and its level decreased (16.99±1.11 IU/l) significantly in the last trimester of pregnancy. AST was increased considerably, and the maximum level (56.55±0.54 IU/l) was observed in the 5th month of pregnancy and decreased after 30 days of kidding. Serum albumin levels were significantly reduced to 2.80±0.04 g/dl as pregnancy advanced and post-kidding. The glucose level significantly decreased (45.02±1.99 mg/dl) up to post-kidding. The stages of pregnancy have significant effects on urea and creatinine. The results of this study concluded that the hemato-biochemical parameters significantly changed with pregnancy and post-kidding in Saanen goats, although the values were within the normal range.

Key words: Saanen goat; pregnancy; hemato-biochemical analysis

ВЛИЈАНИЕ НА ФАЗИТЕ НА ГРАВИДИТЕТОТ И ПЕРИОДОТ ПО ЈАРЕЊЕ ВРЗ ХЕМАТОЛОШКИОТ И БИОХЕМИСКИОТ ПРОФИЛ КАЈ СААНСКИТЕ КОЗИ

А п с т р а к т: Студијава имаше за цел да истражи како варираат параметрите на хематолошкиот и биохемискиот статус во текот на различните фази од гравидитетот и пост-партум периодот кај кози од саанската раса, одгледувани во Центарот за истражување во козарското производство во северен Пакистан. Во студијата по случаен избор беа вклучени вкупно 30 кози на возраст од 2 до 4 години, со просечна телесна маса од 40 ± 2.5 kg. Крвните проби беа земани во фазата на не-гравидност (ден 0), потоа 45-ти, 90-ти и 135-ти ден од гравидитетот и 30-ти ден по јарењето (180-ти ден, фаза на лактација) и од нив беа анализирани хематолошките (WBC – број на леукоцити, RBC – број на еритроцити, Hb – хемоглобин, PCV – хематокрит, MCV – волумен на еритроцити, MCH – ниво на хемоглобин во еритроцити, MCHC – концентрација на хемоглобин во еритроцити) и биохемиските параметри (ALP – алкална фосфатаза, ALT – аланин аминотрансфераза, AST – аспартат

аминотранфераза, серумски албумини, глукоза, калциум, уреа и креатинин). Резултатите покажаа дека параметрите WBC, RBC, Hb, MCH, и MCHC значително варираат помеѓу фазите на гравидитетот и пост-парталниот период, додека кај параметрите PCV и MCV не беа забележани сигнификантни разлики. Нивото на леукоцити (WBC) сигнификантно ($14.28\pm0.25\cdot10^3/\mu l$) беше зголемено на 135-тиот ден од гравидитетот. Нивото на еритроцити (RBC) беше повисоко ($11.44\pm0.15\cdot10^6/\mu l$) кај негравидните кози и беше сигнификантно намалено ($P<0.05$) во доцниот гравидитет до ниво од $9.22\pm0.066\cdot10^6/\mu l$. Слично, нивото на хемоглобин (Hb) беше сигнификантно покачено (10.12±0.107 g/dl) во последната фаза од гравидитетот. Параметрите MCH и MCHC беа намалени со текот на гравидитетот и во периодот по јарењето. Нивото на ALT сигнификантно беше променето 90-тиот ден од гравидитетот и неговото ниво сигнификантно опадна (16.99±1.11 IU/l) во последното тромесечје од гравидитетот. Нивото на AST се зголемуваше значајно со напредокот на гравидитетот и највисоко ниво (56.55±0.54 IU/l) достигна во 5-тиот месец од гравидноста, за потоа повторно да опадне 30 дена по јарењето. Со напредокот на гравидитетот, како и во периодот по јарењето, нивото на серумски албумини сигнификантно се намалуваше сè до вредноста од 2.80±0.04 g/dl. Нивото на глукоза значително се намалуваше со напредокот на гравидноста и достигна ниво од 45.02±1.99 mg/dl забележано во периодот по јарењето. Фазите на гравидитетот имаа значително влијание на нивоата на уреа и креатинин во крвта. Резултатите од оваа студија покажаа дека хематолошките и биохемиските параметри во текот на бременоста и во периодот пост-партум кај саанските кози вклучени во истражувањето сигнификантно варираа, но тие вредности се движеа во рамките на нормалните граници.

Клучни зборови: саански кози; гравидитет; хематолошка анализа; биохемиска анализа

1. INTRODUCTION

One of the first animals that humans domesticated was the goat, which is a polyestrous animal. Goats are domesticated worldwide and utilized for milk production, meat production, fibre production, and biomedical research (FAO, 2003). The type of feeding method, amount of feeding management, and accessibility of nutrients for high production all affect how efficiently goats are produced (Devendra, 1981). Goats choose feeds at the trough or vegetation fractions, specifically during pasturing, and reject more feed than other ruminants if feed availability is unlimited (Morand-Fehr, 2003). The goat is regarded as the poor man's cow in Pakistan. There are 36 number of goat breeds in Pakistan, with the documented goat breeds of Khyber Pakhtunkhwa being the Damani, Gaddi, and Kaghani (Khan et al., 2008).

The Saanen goat is regarded as the most advanced and milk-producing breed in the world. Due to their high daily milk production and relatively low fat content, Saanen goats are frequently referred to as Holstein Friesian and are likened to the Holstein dairy cow breed. The Saanen Valley in central Switzerland is where Saanen goats originated (Devendra et al., 2011).

Animal health status may be determined with high accuracy and regularity using blood. According to research (Ozyurtlu et al., 2007), numerous animal species experience adjustments to some restrictions during lactation and the period following birth. It is well-established that biochemical and hematological parameters are influenced by diet, age, sex, pregnancy, and estrus (Balıkcı et al., 2007). Serum biochemical parameters play a crucial role in maintaining the body's homeostasis. As a result, they offer crucial indicators of how the body is responding to and producing disease, as well as being crucial in the diagnosis of many illnesses. Age and sex affect these metabolic parameters (Parmar et al., 2017). According to Zulkifli et al. (2010), blood serum metabolite and enzyme concentrations directly impact physiological events in goats. Hematochemical parameters are influenced by some variables, including temperature, reproductive status, metabolic disorders, age, sex, breed, the season of the year, stress from management and road travel, and infectious processes (Piccione et al., 2013; Mahmood et al., 2015; and Arfuso et al., 2016).

The hematochemical parameters may be influenced by management practices such as feeding, health, and productivity (Bani Ismail et al., 2008; Waziri et al., 2010). Manat et al. (2016) emphasized the significance of figuring out whether variations in physiological and metabolic phases (such as pregnancy, post-kidding, and various developing fetuses) are related to normal reference hematochemical values. This information can be utilized to clarify numerous additional physiological pathways in goats and for disease diagnosis and prognosis, adaptation criteria, and other objectives (Gokdal, 2013). This study aims to assess how Saanen goats hematological and biochemical markers change during pregnancy and after kidding.

Objectives: i) To evaluate the hematological and biochemical parameters before pregnancy in Saanen goats. ii) To evaluate the hematological and biochemical parameters during different stages of pregnancy in Saanen goats. iii) To evaluate the hematological and biochemical parameters after kidding in Saanen goats.

2. MATERIALS AND METHODS

2.1. *Study area*

The study was carried out from October 2022 to April 2023 at the Goat Production Research Station (GPRS), Charbagh, District Swat, and the Center of Animal Nutrition (CAN) at Livestock Research and Dairy Development (LR&D), Peshawar.

2.2. *Experimental animals and management*

Apparently healthy, Saanen female goats (*n* = 30*)* aged 2–4 years with an average body weight of 40±2.5 kg were randomly selected for the study. The body condition score (BCS) for goats during the trial were recorded as 2.5–3.5 (scale 1–5). All the experimental goats were housed in the shed, which had a concrete floor and bedding. The mean environmental temperature during the study period was 9–21 °C, and the average relative humidity ranged from 41% to 88%. The goats were dewormed with Fenbendazole @ 10 mg/kg body weight before the experimental trial. The animals were free of ectoparasites. The vaccination protocol was followed as per the approved schedule. The animals were grazed for 2–3 hours daily; apart from grazing, all the experimental goats received a daily diet of Rhode grass hay @ 0.3–0.6 g/head/day, green fodder @ 3–5 kg, and concentrate/dairy goat vanda @ 0.5–0.8 kg/day/head, supplemented with goat premix @ 20 g/head/day. Fresh and clean water was provided ad libitum.

The goats were estrous-synchronized in October 2022 and naturally bred with an adult Saanen buck. The pregnancy of goats was determined after 40 days of gestation using real-time ultrasound (Sono Scan E1V, China) equipped with a convex 3.5 MHz transabdominal transducer (Chison C3-A, China) to visualize the presence of an embryo/fetus within the uterus. For clear visualization of the uterus, the hairs were removed from the right side above the udder and in front of the hind leg. Then the gel was applied to the probe and placed on the specified site. The kidding of Saanen goats occurred in March 2023.

2.3. *Sample collection*

A blood sample (5 ml) from each goat was collected at different stages (Table 1) from the jugular vein aseptically in the EDTA tube (2 ml) and serum separating tube (3 ml). The samples were stored at 4°C till further use. The blood was collected in the morning before feeding and watering the goats because fasting has been recommended before the measurements of hematochemical parameters (Rezaei et al., 2013; Yatoo et al., 2015).

Table 1

Experimental layout for blood collection

S. No.	No. of goats	Day of blood collection	Stage
1	30	0	Non-pregnant (Control)
2	30	45th	Early pregnancy
3	30	90th	Mid pregnancy
4	30	135th	Late pregnancy
5	30	180th	Lactation (after 30 days of kidding)

2.4. *Hematological analysis*

The blood samples were sent to CAN, LR&D Peshawar, in an ice box with ice packs for a complete blood count (CBC) using a veterinary hematology analyzer.

2.5. *Biochemical analysis*

The biochemical parameters, including alkaline phosphatase (ALP), alanine transaminase (ALT), aspartate aminotransferase (AST), albumin, glucose, calcium, urea, and creatinine, were measured using commercially available kits (Innoline®, France) through a chemistry analyzer (Erba Mannheim, Germany) at the Laboratory of GPRS, Charbagh, Swat.

2.6. *Statistical analysis*

The data was compiled in Microsoft Excel, and one-way ANOVA and descriptive statistics were applied for analysis using Statistix 10 software.

3. RESULTS

3.1. *Hematological analysis*

The mean values of different hematological parameters in various stages are given in Table 2. WBC, RBC, Hb, MCH, and MCHC were significantly affected by non-pregnancy, pregnancy stages, and post-kidding, while no significant difference was observed in PCV and MCV. The WBC level increased from 12.20±0.93×10^3/µl in the non-pregnant stage to 14.28±0.25×10^3/µl on the 135th day of pregnancy. The total RBC count was higher (11.44±0.15×10^6/µl) in the non-pregnant stage and

decreased significantly ($P < 0.05$) on the 135th day of pregnancy (9.22±0.066×10^6/µl). Similarly, Hb levels significantly increased in pregnancy stages, and a higher level of Hb (10.12±0.107 g/dl) was observed in late pregnancy and decreased to 9.15±0.301 g/dl after 30 days of kidding. MCH and MCHC levels decreased with advanced pregnancy and post-kidding. The higher and lower values of MCH (8.48±0.18 pg and 7.95±0.12 pg) were found in the non-pregnant stage and the post-kidding stage, respectively. The MCHC value was recorded higher (32.75±0.48 g/dl) in the non-pregnant stage and significantly decreased (31.02±0.31 g/dl) on the 135th day of pregnancy.

Table 2

Effect of pregnancy stages and post-kidding on the hematological profile of Saanen goats

Parameters	(Day 0) Non pregnant	(45th day) Early pregnancy	(90th day) Mid pregnancy	(135th day) Late pregnancy	(30 days after kidding) Lactation	p-value
WBC (10^3/µl)	12.20^{b}±0.93	12.31^{b}±0.33	12.5^{b}±0.17	14.28^{a}±0.25	12.43^{b}±0.18	0.011
RBC (10^6/µl)	11.44^{a}±0.15	10.58^{b}±0.13	10.56^{b}±0.12	9.22^{c}±0.066	10.51^{b}±0.13	0.000
Hb (g/dl)	9.75^{ab}±0.28	9.27^{b}±0.27	9.04^{b}±0.25	10.12^{a}±0.107	9.15^{b}±0.301	0.015
PCV (%)	30.11±0.65	29.94±0.54	29.53±0.47	29.24±0.62	30.45±0.32	0.534
MCV (fl)	17.82±0.12	17.07±0.12	17.73±0.37	17.56±0.27	17.35±0.25	0.216
MCH (pg)	8.48^{a}±0.18	8.42^{a}±0.08	8.21^{ab}±0.10	8.18^{ab}±0.09	7.95^{b}±0.12	0.020
MCHC (g/dl)	32.75^{a}±0.48	32.23^{ab}±0.46	31.34^{b}±0.35	31.02^{b}±0.31	31.46^{b}±0.50	0.033

Mean (±SE) values within rows with different superscript letters are significantly different ($P < 0.05$).
WBC = white blood cell, RBC = red blood cell, Hb = hemoglobin, PCV = packed cell volume,
MCV = mean corpuscular volume, MCH = mean corpuscular hemoglobin, MCHC = mean corpuscular hemoglobin concentration.

3.2. *Biochemical analysis*

The data on the effect of different pregnancy stages and post-kidding on the biochemical profile of Saanen goats are shown in Table 3. All the parameters except ALP and calcium were significantly affected by pregnancy and after kidding ($P<0.05$). The liver-associated enzymes ALT and AST were significantly affected. ALT was affected after the 3rd month of pregnancy, and its level decreased significantly in the 5th month of pregnancy. AST was significantly increased, and the maximum level (56.55±0.54 IU/l) was observed in the 5th month of pregnancy and decreased after 30 days of kidding. Serum albumin levels were high (3.21±0.09 g/dl) before pregnancy (day 0) and declined as pregnancy advanced and post-kidding. The glucose level significantly decreased up to post-kidding. The calcium level was not significantly ($P>0.05$) affected, but a numerical maximum level of 12.70±2.73 mg/dl was observed on the 45th day of pregnancy. Urea and creatinine were significantly affected by the advancement of pregnancy. The higher concentration (42.73±0.414 mg/dl) of blood urea was recorded before pregnancy, while a higher creatinine value of 1.302±0.09 mg/dl; was observed in late pregnancy.

Table 3

Effect of pregnancy stages and post-kidding on the biochemical profile of Saanen goats

Parameters	(Day 0) Non pregnant	(45th day) Early pregnancy	(90th day) Mid pregnancy	(135th day) Late pregnancy	(30 days after kidding) Lactation	P-value
ALP (IU/l)	257.35±10.9	220.44±12.2	232.59±14.08	314.21±13.87	258.95±11.74	0.30
ALT (IU/l)	23.65^{a}±1.5	23.53^{a}±1.09	23.25^{a}±0.94	16.99^{b}±1.11	18.77^{b}±1.33	0.001
AST (IU/l)	53.68^{bc}±0.56	54.18^{bc}±0.47	54.51^{b}±0.45	56.55^{a}±0.54	52.87^{c}±0.64	0.001
Albumin (g/dl)	3.21^{a}±0.09	3.10^{a}±0.08	3.10^{a}±0.03	2.80^{b}±0.04	2.88^{b}±0.07	0.002
Glucose (mg/dl)	69.88^{a}±2.27	58.73^{bc}±1.74	59.37^{b}±0.90	53.53^{c}±2.70	45.02^{d}±1.99	0.000
Calcium (mg/dl)	9.10±0.12	12.70±2.73	10.01±0.13	11.65±0.16	11.30±0.24	0.266
Urea (mg/dl)	42.73.^{a}±0.414	34.45^{b}±2.16	35.33^{b}±3.48	36.72^{b}±1.89	36.15^{b}±1.92	0.030
Creatinine (mg/dl)	0.85^{b}±0.02	0.87^{b}±0.03	0.87^{b}±0.02	1.302^{a}±0.09	0.73^{b}±0.02	0.000

Mean (±SE) values within rows with different superscript letters are significantly different ($P < 0.05$).
ALP = alkaline phosphatase, ALT = alanine aminotransferase, AST = aspartate aminotransferase.

4. DISCUSSION

The current study was conducted for the first time on Saanen goats in Pakistan to determine the hematological and biochemical profile among non-pregnant, early pregnancy, mid-pregnancy, late pregnancy, and post-kidding stages of Saanen goats reared in Swat, Khyber Pakhtunkhwa. Blood can be used as a reliable and accurate source to detect the health state of animals. Many species of animals adjust to some conditions after parturition and during lactation (Ozyurtlu et al., 2007). It is widely known that diet, age, sex, pregnancy, and estrus affect biochemical and hematological parameters (Balıkcı et al., 2007).

The hematological parameters are significantly different during pregnancy and post-kidding in goats. In the present study, the WBC level increased significantly ($P<0.05$) from $12.20 \cdot 10^3$/µl in the non-pregnant stage to $14.28 \cdot 10^3$/µl on the 135th day of pregnancy. These results agree with the findings of Jain (1993), in which the WBC count increased gradually during gestation until kidding. The level of RBC in this study was significantly ($P<0.05$) decreased ($9.22 \cdot 10^6$/µl) in late pregnancy as compared to the non-pregnant stage and the early and mid-pregnancy stages. Similar results were found in bitches, mares, sows, and sheep (Jain, 1993); in Saanen goats (Biagi et al., 1988), and in Danish landrace goats (Mbassa and Poulsen, 1991). This decrease in the RBC count may be due to the hemodilution effect as a result of the increase in plasma volume, which improves the blood flow through placental vessels to increase the diffusion of oxygen and nutrients to the fetus (Guyton and Hall, 1991; Pere et al., 1996; Azab et al., 1999; and Iriadam, 2007).

In the present study, PCV values were not significantly ($P>0.05$) affected by the stages of pregnancy; however, a low level of PCV (29.24±0.62%) was observed in the late stage of pregnancy. These results are following the findings of Brito et al. (2006) and Aiche et al. (2020), who found that PCV percentage decreased with advancing pregnancy in ewes. The Hb values were significantly increased (10.12±0.107 g/dl) on the 135th day of pregnancy during the experiment. Similar results were observed in ewes at the end of gestation by Adeyeye et al., 2016, and El-Malky et al. (2019) and in local black goats by Bamerny et al., 2022. This increase may result from the increased demand for oxygen and a greater metabolic rate during pregnancy, as well as hemodilution.

The results of RBC indices showed that a non-significant difference was found in the values of MCV, but the values of MCH and MCHC were significantly decreased in the late pregnancy stage as compared to other pregnancy stages, non-pregnancy and after 30 days of kidding. Mbassa and Poulsen (1991) also reported that the values of MCV, MCH, and MCHC increased during pregnancy and lactation.

The biochemical profile of the goats in the current study revealed that, except ALP and calcium, all the biochemical parameters were significantly ($P<0.05$) different in the non-pregnant, early pregnancy, mid-pregnancy, late pregnancy, and post-kidding stages.

The findings show that the phases of pregnancy have an impact on AST levels, and the late pregnancy stage had significantly higher AST levels (56.55±0.54) than other stages ($P<0.05$) (Table 3). These findings agree with those made by (El-Ghoul et al., 2000; Antunović et al., 2004; Stojević et al., 2005; Juma et al., 2009; and Zebari et al., 2013). The increased metabolism of the liver during the pregnancy stages may cause this rise in the AST enzyme (Okab et al., 1993). In contrast to pregnant and lactating goats, non-pregnant goats had greater levels of ALT. The uterine and reproductive hormonal changes that occur during pregnancy cause the decrease in ALT activity in pregnant goats. The current findings are comparable to those reported by Tainturier et al., 1984, and Lashari et al., 2021, who reported that the activity of ALT decreased in the final stages of pregnancy and remained stable at the beginning of lactation.

The albumin level in the blood serum was significantly lower in the late pregnant and post-kidding stages of goats compared to the non-pregnant stage, early pregnancy, and mid-pregnancy. Pregnant and non-pregnant goats of the Croatian, Red Syrian, Saanen, and Oberhasli breeds showed similar results (Žubćić, 2001; Celi et al., 2008; Castagnino et al., 2015). Combining these findings, it indicates that blood albumin was directed toward fetal development tissue.

As the pregnancy advanced, the glucose levels dropped considerably ($P<0.05$). The greater energy needs of a growing fetus or the impact of fetal insulin are likely the reasons for the decrease in blood glucose levels (Payne et al., 1970). Similar results of decreasing blood glucose levels during pregnancy were reported by (Balıkcı et al., 2007; Waziri

et al., 2010; and Sahu et al., 2015). Our results disagree with those of Abdul-Rehaman et al., 2019, who found that blood glucose levels were significantly higher in pregnant animals, indicating that the glucose may have been immobilized by the use of adrenergic alpha-2 anesthetics, which block the release of insulin and increase glucose output from the liver (Abdul-Rahaman et al., 2019; Soveri et al., 1999).

In this study, urea significantly ($P<0.05$) decreased in the pregnancy stages of goats as compared to the non-pregnant stage. The urea reduction may be due to a decrease in amino acid catabolism, which reduces urea synthesis. The results of the current study concur with those of earlier researchers. According to Abdul-Rahaman et al., 2019, urea was significantly higher ($P<0.05$) in non-pregnant goats and markedly lower in pregnant ones. Because of stress and hormonal changes during the kidding process, there may be a correlation between the drop in serum BUN around parturition and the decrease in feed intake (Sadjadian et al., 2013). The creatinine value (1.302 mg/dl) was significantly increased on the 135th day of pregnancy. Similar results were reported by (Sahu et al., 2013; Elzein et al., 2016; Ismaeel et al., 2018, and Cepeda-Palacios et al., 2018) in which creatinine concentrations in doe during late pregnancy were higher than normal. According to Elzein et al. (2016), creatinine is a metabolic residue that is produced normally when a maternal protein mobilizes for the development of fetal tissue and the removal of organic waste.

5. CONCLUSION

This study concluded that some hematological and biochemical parameters significantly changed during pregnancy and post-kidding in Saanen goats. These changes may be due to modifying the goat's metabolism to fulfill the requirements for the developing fetus in the pregnancy stages and lactation after kidding. Maternal tissues deliver energy for reproductive activities during pregnancy, which may impact many serum biochemical parameters. Furthermore, this study suggests that goats require high energy during the last stages of pregnancy and the pot-kidding stage to meet the requirements of kids and doe for maximum production.

REFERENCES

Abdul-Rahaman, Y. T., Humid, A. O., Al-Dulaimi, H. S. H. (2019): Effect pregnant and non-pregnant on haematological and biochemical parameters of Qatari goats in Iraq. *Indian Journal of Public Health*, **10** (10), 2743–2748.

Adeyeye, A. A., Ate, I. U. (2016): Blood profile of ewes during third trimester of pregnancy and lactation. *Bull. Anim. Hlth. Prod. Afr*, **64**, 475–482.

Aiche, S., Smail, F., Chikhaoui, M., Abdelhadi, S. A. (2020): Factors influencing the hematological parameters in ewes of the Rembi breed during late pregnancy in Tiaret region, west of Algeria. *Alexandria Journal for Veterinary Sciences*, **66** (1), 111. DOI:10.5455/ajvs.97679

Antunović, Z., Šperanda, M., Steiner, Z. (2004): The influence of age and the reproductive status to the blood indicators of the ewes. *Archives Animal Breeding*, **47** (3), 265–273. https://doi.org/10.5194/aab-47-265-2004

Arfuso, F., Rizzo, M., Giannetto, C., Giudice, E., Fazio, F., Piccione, G. (2016): Age-related changes of serum mitochondrial uncoupling 1, rumen and rectal temperature in goats. *Journal of Thermal Biology*, **59**, 47–51. DOI:10.1016/j.jtherbio.2016.05.002

Azab, M. E., Abdel-Maksoud, H. A. (1999): Changes in some hematological and biochemical parameters during prepartum and postpartum periods in female Baladi goats. *Small Ruminant Research*, **34** (1), 77–85.

Bamerny, A. O., Barwary, M. S., Alkass, J. E. (2022):. Changes in some haematological and biochemical parameters in local black goats during pregnancy. *Iraqi Journal of Agricultural Sciences*, **53** (2), 378–384.

Biagi, G., Romagnoli, A., Bagliacca, M., Leto, A. (1988): The use of the metabolic profile test in a Saanen goat herd. *Annali della Facolta di Medicina Veterinaria di Pisa (Italy)*.

Balıkcı, E., Yıldız, A., Gürdoğan, F. (2007): Blood metabolite concentrations during pregnancy and postpartum in Akkaraman ewes. *Small Ruminant Research*, **67** (2–3), 247–251.

Bani Ismail, Z. A., Al-Majali, A. M., Amireh, F., Al-Rawashdeh, O. F. (2008): Metabolic profiles in goat does in late pregnancy with and without subclinical pregnancy toxemia. *Veterinary Clinical Pathology*, **37** (4), 434–437.

Brito, M. A., González, F. D., Ribeiro, L. A., Campos, R., Lacerda, L., Barbosa, P. R., Bergmann, G. (2006): Blood and milk composition in dairy ewes from southern Brazil: variations during pregnancy and lactation. *Ciência Rural*, **36**, 942–948.

Castagnino, D. D. S., Härter, C. J., Rivera, A. R., Lima, L. D. D., Silva, H. G. D. O., Biagioli, B., ... & Teixeira, I. A. M. D. A. (2015): Changes in maternal body composition and metabolism of dairy goats during pregnancy. *Revista Brasileira de Zootecnia*, **44**, 92–102.

Celi, P., Di Trana, A., Claps, S. (2008): Effects of perinatal nutrition on lactational performance, metabolic and hormonal profiles of dairy goats and respective kids. *Small Ruminant Research*, **79** (2–3), 129–136.

Cepeda-Palacios, R., Fuente-Gómez, M. G., Ramírez-Orduña, J. M., García-Álvarez, A., Llinas-Cervantes, X., Angulo, C. (2018): Effects of pregnancy and post-kidding stages on haematochemical parameters in cross-bred goats. *Journal of Applied Animal Research*, **46** (1), 269–273.

Devendra, C. (1981): Feeding system for goats in the humid tropics. In: *Int. Symp. on Nutrition and Systems of Goat Feeding* (pp. 395–410).

Devendra, C., Haenlein, G. F. W. (2011): *Animals that produce dairy foods. Goat Breeds*. 310–324.

El-Ghoul, W., Hofmann, W., Khamis, Y., & Hassanein, A. (2000): Relationship between claw disorders and the peripartal period in dairy cows. *Praktische Tierarzt*, **81** (10), 862–868.

El-Malky, O. M., Mostafa, T. H., Ibrahim, N. H., Younis, F. E., AM, A. E. S., Tag El-Din, H. A. (2019): Comparison between productive and reproductive performance of Barki and Ossimi ewes under Egyptian conditions. *Egyptian Journal of Sheep & Goats Sciences*, **14** (1).

Elzein, E., Osman, I., Omer, S. A. (2016): Effect of physiological status in some haematological and biochemical parameters in desert goats. *International Journal of Veterinary Science*, **5** (2), 95–98.

FAO (2003). TCP/PAK/0168 Livestock Action Plan, Food and Agriculture Organization of the United Nations, Islamabad, Pakistan.

Gokdal, Ö. (2013): Growth, slaughter and carcass characteristics of Alpine × Hair goat, Saanen × Hair goat and Hair goat male kids fed with concentrate in addition to grazing on rangeland. *Small Ruminant Research*, **109** (2–3), 69–75.

Guyton, A. C., Hall, J. E. (1991): Text Book of Medical Physiology, 8th ed. VVB Saunders, Philadelphia, pp. 168–1036.

Iriadam, M. (2007): Variation in certain hematological and biochemical parameters during the peri-partum period in Kilis does. *Small Ruminant Research*, **73** (1–3), 54–57.

Ismaeel, M. A., Awad, A. H., Dhahir, N. N. (2018): Assessment of alterations in some blood biochemical and mineral contents concentration before and during pregnancy period in Iraqi ewes of Salah-edin province. *Iraqi J Vet Sci*, **32** (2), 161–165.

Jain, N. C. (1993): *Essentials of Veterinary Hematology*. 5th ed. Lea and Febiger, Philadelphia.

Juma, F. T., Maroff, N. N., Mahmood, K. T. (2009): Effect of some hormones on reproductive performance and some serum biochemical changes in synchronized black goats. *Iraqi Journal of Veterinary Sciences*, **23** (2).

Khan, M. S., Rehman, Z., Khan, M. A., Ahmad, S. (2008): Genetic resources and diversity in Pakistani cattle. *Pak Vet J*, **28** (2), 95–102.

Lashari, M. H., Ahmad, I., Masood, S., Farooq, U., Anam, M., Akhtar, M. S., ... & Nawaz, M. (2021): Hematological and biochemical parameters of pregnant and lactating goats in Rangeland of Cholistan Desert, Bahawalpur, Pakistan. *Journal of the Hellenic Veterinary Medical Society*, **72** (1), 2781–2786.

Mahmood, Z. K. H., Jesse, F. F., Saharee, A. A., Jasni, S., Yusoff, R., Wahid, H. (2015): Assessment of blood changes post-challenge with Corynebacterium pseudotuberculosis and its exotoxin (phospholipase D): A comprehensive study in goat. *Veterinary World*, **8** (9), 1105.

Manat, T. D., Chaudhary, S. S., Singh, V. K., Patel, S. B., Puri, G. (2016): Hematobiochemical profile in Surti goats during post-partum period. *Veterinary World*, **9** (1), 19.

Mbassa, G. K., Poulsen, J. S. (1991): Influence of pregnancy, lactation and environment on haematological profiles in Danish landrace dairy goats (Capra hircus) of different parity. *Comparative Biochemistry and Physiology. B, Comparative Biochemistry*, **100** (2), 403–412.

Morand-Fehr, P. (2003). Dietary choices of goats at the trough. *Small Ruminant Research*, **49** (3), 231–239.

Okab, A. B., Elebanna, I. M., Mekkawy, M. Y., Hassan, G. A., El Nouty, F. D., Salem, M. H. (1993): Seasonal changes in plasma thyroid hormones, total lipids, cholesterol and serum transaminases during pregnancy and at parturition in Barki and Rahmani ewes. *Indian Journal of Animal Sciences (India)*.

Ozyurtlu, N., Gürgöze, S. Y., Bademkıran, S., Şimşek, A., Çelik, R. (2007): Investigation of some biochemical parameters and mineral substance levels in prenatal and postnatal period in Awassi sheep. s. *Firat Univ J Health Sci*, **21** (1): 33–36.

Parmar, R., Lateef, A., Das, H., Haque, N., Sanap, M., Solanki, V. (2017): Effect of age, sex and physiological stages on haematological indices of Mehsana goat (Capra hircus). *Int J Livestock Res*, **7** (4), 236–43.

Payne, J. M., Dew, S. M., Manston, R., Faulks, M. (1970): The use of a metabolic profile test in dairy herds. *Veterinary Record*, **87** (6), 150–158.
DOI: 10.1136/vr.87.6.150.

Pere, M. C., Dourmad, J. Y., Etienne, M. (1996): Variation of uterine blood flow in the sow during gestation. In: *28. Journees de la Recherche Porcine en France.[28. French Swine Research Days]. Paris (France). 30 Jan – 1 Fev 1996.*

Piccione, G., Casella, S., Giannetto, C., Bazzano, M., Giudice, E., Fazio, F. (2013): Oxidative stress associated with road transportation in ewes. *Small Ruminant Research*, **112** (1–3), 235–238.

Rezaei, J., Rouzbehan, Y., Fazaeli, H., Zahedifar, M. (2013): Carcass characteristics, non-carcass components and blood parameters of fattening lambs fed on diets containing amaranth silage substituted for corn silage. *Small Ruminant Research*, **114** (2–3), 225–232.

Sadjadian, R., Seifi, H. A., Mohri, M., Naserian, A. A., Farzaneh, N. (2013): Variations of energy biochemical metabolites in periparturient dairy Saanen goats. *Comparative Clinical Pathology*, **22**, 449–456.

Sahu, S., Babu, L. K., Karna, D. K., Behera, K., Kanungo, S., Kaswan, S., ... & Patra, J. K. (2013): Effect of different level of concentrate supplementation on the periparturient growth performance of Ganjam goat in extensive system. *Veterinary World*, **6** (7).

Sahu, S., Babu, L. K., Karna, D. K., Behera, K., Kanungo, S., Kamal, R., & Upadhyay, D. (2015): Effect of prepartum concentrate supplementation on blood biochemical profiles of pregnant Ganjam goat. *Indian Journal of Animal Research*, **49** (4), 487–490.

Soveri, T., Sankari, S., Salonen, J. S., Nieminen, M. (1999): Effects of immobilization with Medetomidine and Reversal with Atipamezole on blood chemistry of semi-domesticated reindeer (*Rangifer tarandus tarandus* L.) in autumn and late winter. *Acta Veterinaria Scandinavica*, **40** (4), 335–349.

Stojević, Z., Piršljin, J., Milinković-Tur, S., Zdelar-Tuk, M., Beer Ljubić, B. (2005): Activities of AST, ALT and GGT in clinically healthy dairy cows during lactation and in the dry period. *Veterinarski arhiv*, **75** (1), 67–73.

Tainturier, D., Braun, J. P., Rico, A. G., Thouvenot, J. P. (1984): Variations in blood composition in dairy cows during pregnancy and after calving. *Research in Veterinary Science*, **37** (2), 129–131.

Waziri, M. A., Ribadu, A. Y., Sivachelvan, N. (2010): Changes in the serum proteins, hematological and some serum biochemical profiles in the gestation period in the Sahel goats. *Vet. arhiv*, **80** (2), 215–224.

Yatoo, M. I., Deepa, P. M., Mandal, R. S. K., Sharma, B., Mendiratta, S. K., Patel, B. H. M., Dimri, U. (2015): Prevalence of subclinical diabetes in a commercial flock of dairy goats in India and its interaction with milk quality. *Small Ruminant Research*, **132**, 1–11.

Zebari, H. M. H., Buti, E. T. S., Hamo, R. A. H. (2013): Some blood biochemical parameters of meriz does during different physioloigical status. *Scientific Journal of Animal Science*, **2** (7), 190–194.

Žubčić, D. (2001): Some biochemical parameters in the blood of grazing German improved fawn goats from Istria, Croatia. *Veterinarski arhiv*, **71** (5), 237–244.

Zulkifli, I. D. R. U. S., Bahyuddin, N., Wai, C. Y., Farjam, A. S., Sazili, A. Q., Rajion, M. A., Goh, Y. M. (2010): Physiological responses in goats subjected to road transportation under the hot, humid tropical conditions. *Int. J. Agric. Biol*, **12** (6), 840–844.