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RESEARCH ARTICLE

Metabolic Profiles of Healthy Pre- and Post-Partum Aardi Goats (*Capra hircus*) and Kids in Saudi Arabia

Mohamed J Al-Hassan*

Department of Animal Production, College of Food and Agriculture Sciences, King Saud University, Riyadh, Saudi Arabia
*Corresponding author: mjalhassan@gmail.com

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ABSTRACT

Aardi goats are native to Saudi Arabia and represent the majority of its goat population. They are also known to have high genetic variability in comparison to other goat breeds found all over the world. When it comes to scientific data related to such an important breed, detailed information is lacking on how to help improve the production and reproduction of the breed. This study monitored the metabolic profiles by taking blood samples of Aardi goats weekly, from 4 weeks before until 4 weeks post-partum. In addition, weekly blood samples of their kids were taken until 4 weeks of age. Serum albumin, total protein, cholesterol, and urea concentrations were examined. Pre-partum serum albumin concentrations were significantly lower than those from the post-partum period. There was no significant difference in total protein concentrations between the pre- and post-partum periods. Serum cholesterol was significantly higher during the pre- than the post-partum period. Serum urea concentrations at 3 and 2 weeks pre-partum were significantly higher than those observed -1, 0, 2, 3, and 4 weeks from parturition, and the lowest concentrations were observed -1, 0, 3, and 4 weeks from parturition. In contrast to their mothers, serum cholesterol concentrations of kids increased from 1 to 4 weeks of age, while serum urea concentrations decreased in accordance with their mothers. These results indicate that Aardi goats have certain metabolic profiles that differ from other goat breeds during pre- and post-partum periods.

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INTRODUCTION

Metabolic profiles have been used to evaluate animal health and to diagnose certain diseases and nutritional deficiencies. Metabolites such as albumin, protein, cholesterol, and urea are important indicators of the health and nutritional status of an animal. For example, increased serum urea concentrations could be associated with renal failure and/or dehydration (Mishra *et al.,* 2013). Time and nutrition significantly affect the concentrations of albumin, protein, cholesterol and urea in goats, from 4 weeks pre-partum to 4 weeks post-partum (Castagnino *et al.,* 2015). For instance, goats with pregnancy toxemia exhibited decreased albumin, protein, and cholesterol concentrations and increased serum urea, as compared with those of healthy goats (Vasava *et al.,* 2016).

Colostrum provides nutrients to newborn kids, and its consumption affects serum biochemical variables, such as serum protein and lipid concentrations (Abdolvahabi *et al.,* 2016). Increased serum concentrations of cholesterol in kids could be related to the high fat content in colostrum and milk, as there is a rapid rise in serum lipids in kids (Ashour *et al.,* 2015) several weeks after birth. The serum urea concentration is used as an indicator of renal excretion efficiency, thus enabling the observation of postnatal adaptation of calves at this critical stage of life (Herosimczyk *et al.,* 2011).

The majority of the 1.06 million goats in Saudi Arabia are of Aardi breed. These native Aardi goats have high genetic variability in comparison to other goat breeds of the world, and the importance of this breed is apparent in their adaptability to local environments (Al-Samawi *et al.,* 2014) and their production of milk and meat. The breed has been raised in a nomadic manner without any type of intensive breeding, and little is known about their biochemical status during late pregnancy and the early post-partum period, which is an important indication of the health status of the animals, especially in arid and semi-arid areas of Saudi Arabia.

Pre-partum and early post-partum periods have major effects on dairy animals, since they undergo significant metabolic adaptations and stresses (Contreras and Sordillo, 2011), which in turn, affect their productivity. To the best of our knowledge, there is no data on such metabolites during pre- and post-parturition periods in Aardi goats.

The aim of this study is to investigate the values of serum albumin, total protein, cholesterol and urea in the 4 weeks pre- and 4 weeks post-partum periods in Aardi goats, in addition to investigating the values of such parameters in kids until 4 weeks of age. This information will be of interest to elucidate the changes during the specified periods, in comparison to the serum profiles in kids.

MATERIALS AND METHODS

The study was conducted at the Department of Animal Production Research Station, King Saud University. All the experimental procedures were approved by the Faculty Research Ethics Committee at King Saud University. Sixteen nulliparous Aardi goats (approximately 1.5 years of age) and two mature males (used for natural mating) were kept in separate shaded pens. Each pen is about 16 m^2 and used to hold 4 goats. For evaluation purposes, semen was collected from bucks via electro ejaculation, and samples were examined under a microscope for quality (e.g., progressive motility and defects) before using the bucks for natural mating. All animals were examined by a veterinarian, dewormed, and vaccinated against enterotoxemia, peste des petits ruminants (PPR), and hemorrhagic septicemia. In addition, the animals were fed alfalfa and concentrates in a total mixed ration, according to National Research Council (NRC) recommendations (NRC, 2007), and water was provided *ad libitum*.

The experiment was conducted during winter, through the months of November and December, and the average temperatures were 21 and 16ºC, respectively (Presidency of Meteorology and Environment, 2006). The animals were also acclimatized for one month before the start of the experiment. Female Aardi goats were synchronized using the OvSynch protocol in combination with natural mating (Al-Hassan *et al.,* 2016). Female goats were monitored to detect estrus behavior, and day 1 of pregnancy was calculated 48 h after the start of estrus.

Blood samples were collected at 8:00 in the morning, in plain tubes via jugular venipuncture (10 mL), at 4, 3, 2, and 1 week before parturition. In addition, blood was collected on the day of parturition as well as at 1, 2, 3, and 4 weeks post-partum. Furthermore, blood samples were taken from 18 kids at 1, 2, 3, and 4 weeks of age. Blood was centrifuged at 1500 × g for 30 min at 4ºC within 1 h of collection, and serum was separated and stored at -20ºC for biochemical analyses.

Serum biochemical parameters (albumin, total protein, cholesterol, and urea) were analyzed using enzyme-linked immunosorbent assay (ELISA) with commercially available ELISA kits (Cayman Chemical, Ann Arbor, Michigan, USA). The assays were performed according to the manufacturer's instructions, and an automatic ELISA microplate reader (Stat Fax 4200, Awareness Technology Inc., USA) was used for absorbance measurements. All pregnancies were checked on day 23 post-breeding using a real-time B-mode machine (Prosound 2, ALOKA, Japan) with a multi-frequency linear trans-rectal probe (UST 660-7.5, ALOKA, Japan). On day 35 post-breeding, goats were confirmed pregnant using a multi-frequency convex trans-abdominal probe (UST-9137C, ALOKA, Japan). Monthly trans-abdominal ultrasonography was performed until the onset of parturition.

A general linear model (GLM) of SAS® (SAS Inst. Inc., Cary, NC, USA) was used to analyze the changes in concentrations of serum albumin, protein, cholesterol and urea within the last 4 weeks of pregnancy, and first 4 weeks from parturition. In addition, a GLM was used to analyze the changes in serum albumin, protein, cholesterol and urea during the first 4 weeks of life in Aardi kids. Completely randomized design (CRD) was applied to analyze the experimental data. Data were expressed as the mean ± standard error (SE) for all parameters. Fisher's least significant difference (LSD) was used at a significance level of $P<0.05$.

RESULTS

Serum albumin concentrations for goats from 4 weeks pre-partum to 4 weeks post-partum, and for newborn kids until the fourth week of age are shown in Fig. 1. Results show a significant ($P<0.05$) decrease in serum albumin from -4 to -1 weeks before parturition, and serum albumin increased significantly ($P<0.05$) from -1 week to 1 week from parturition. Serum albumin concentrations peaked at 1 week post-partum with a small decline during the second week, but concentrations remained slightly (but not significantly) higher than those observed during the four-week pre-partum period. After the first week of life, there was a non-significant increase in serum albumin concentration in kids up to the fourth week of age.

The serum total protein concentrations in goats exhibited a trend similar to that observed in serum albumin changes, but all changes were non-significant (Fig. 2). Serum total protein concentrations started low at -4 weeks, peaked at -3 weeks, and decreased at the time of parturition. Thereafter, these protein concentrations peaked at 3 weeks and decreased again at 4 weeks post-partum. In kids, there were no significant changes in serum total protein concentrations during the first 4 weeks of life or between the first and fourth weeks of age.

Total cholesterol peaked at 4 weeks after parturition, which differed significantly ($P<0.05$) from the lowest concentration at the day of parturition (Fig. 3). No other significant changes were detected. In contrast to the post-partum serum cholesterol concentrations of goats, cholesterol concentrations of kids were much higher, and the concentrations increased between the first and fourth weeks of life (Fig. 3). Serum concentrations during the first week were significantly lower ($P<0.05$) than those detected during the fourth week of life.

Serum urea concentrations changed significantly between 4 weeks pre-partum and 4 weeks post-partum in Aardi goats (Fig. 4). At 4 weeks pre-partum, serum urea concentrations increased gradually, and concentrations peaked at 2 weeks pre-partum. Thereafter, serum urea concentrations decreased significantly ($P<0.05$) 1 week pre-partum. A slight increase in serum urea concentrations was

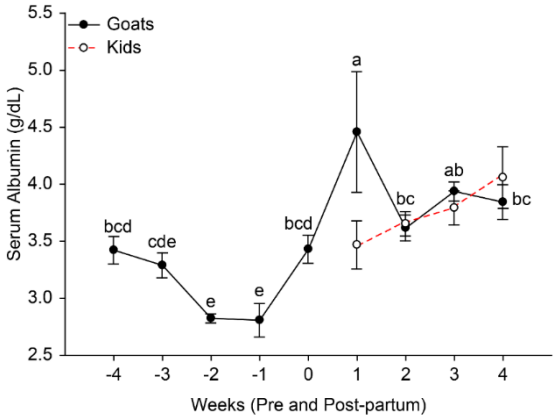

Fig. 1: Serum albumin concentrations (g/dL) in Aardi goats (during pre- and post-partum periods) and kids. Values are expressed as mean ± SE. Different letters indicate statistically significant differences (P<0.05). There were no significant differences in serum albumin concentrations in Aardi kids.

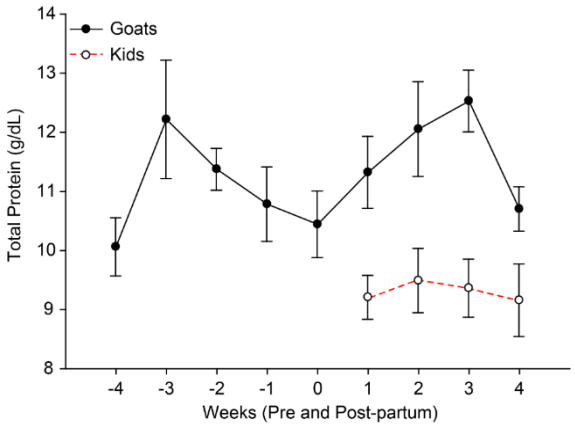

Fig. 2: Serum protein concentrations (g/dL) in Aardi goats (during pre- and post-partum periods) and kids. There were no significant differences among Aardi goats and among Aardi kids.

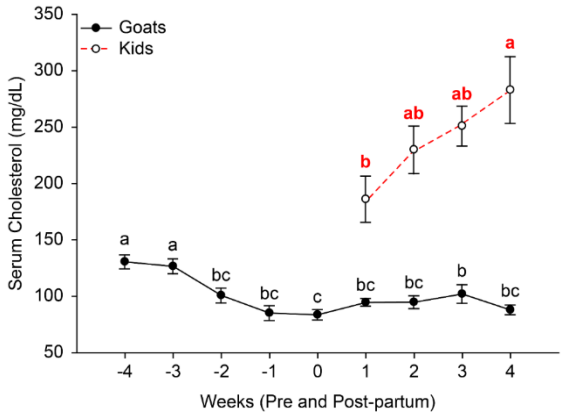

Fig. 3: Serum cholesterol concentration (mg/dL) in Aardi goats (during pre- and post-partum periods) and kids. Values are expressed as mean ± SE. Different letters indicate statistically significant differences (P < 0.05) among Aardi goats and among Aardi kids.

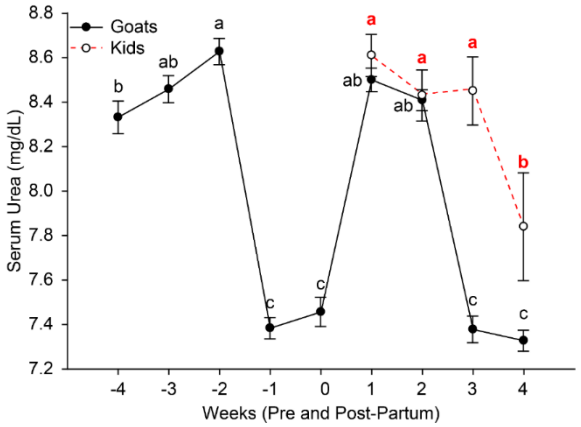

Fig. 4: Serum urea concentration (mg/dL) in Aardi goats (during pre- and post-partum periods) and kids. Values are expressed as mean ± SE. Different letters indicate statistically significant differences (P<0.05) among Aardi goats and among Aardi kids.

detected at parturition and this increase was followed by significant (P<0.05) increases during the first and second post-partum weeks. A significant decrease (P<0.05) in serum urea concentrations was detected during the third and fourth post-partum weeks. Serum urea concentrations in kids did not differ significantly during the first 3 weeks (Fig. 4). However, a decreasing trend was observed as animals neared the age of 4 weeks, as urea concentrations were significantly lower (P<0.05) than concentrations from previous weeks. In addition, newborn kids had significantly higher (P<0.05) serum urea concentrations 3 and 4 weeks post-partum than their mothers.

DISCUSSION

Decreased albumin levels during the pre-partum period could be related to the fact that seven of the 16 goats were pregnant with twins. Studies reported that late pregnancies and twining led to decreased serum albumin in an Egyptian breed of ewes (El-Tarabany, 2012). Pregnancy and parturition (to a lesser extent) are considered demanding and stressful physiological stages that are associated with oxidative stresses (Al-Hassan *et al.*, 2016). Albumin is known to function as a powerful antioxidant (Roche *et al.*, 2008), and this might explain the increased serum albumin concentrations towards the end of gestation. In addition, twin pregnancies place more metabolic demands on pregnant animals, particularly during the late stages of pregnancy. Fetal growth in twin pregnancies was 66% higher than in single pregnancies. During this period, fetal growth between 80 and 140 days of pregnancy corresponded to 92.6% of the total weight of the fetus (Castagnino *et al.*, 2015). Although it is reported that pregnancy toxemia lowers albumin serum concentrations (Vasava *et al.*, 2016), the animals in this study continued to be healthy without any signs of disease.

Post-partum serum albumin concentrations did not exhibit the same trend seen in Surti goats of India (Manat *et al.*, 2016), where serum albumin continued to increase from the time of parturition until 45 days. Our results showed a sharp increase during week 1, which was followed by a decrease and subsequent increase (to a lesser degree) during the third and fourth post-partum weeks. These differences may be related to breed and nutritional differences.

Albumin plays an important role in the metabolic balance in newborns, since it carries and stores amino

acids to prevent their oxidation (van den Akker *et al.*, 2007). It was reported that serum albumin increased from birth until the first week of life in calves (Herosimczyk *et al.*, 2011), and another study reported increased serum albumin concentrations in Saanen × Boer female goat kids from birth until 60 days of age (Lima *et al.*, 2013). Our results of increased serum albumin concentrations in Aardi kids until the age of 4 weeks, agrees with studies in Saanen goat kids in Iran, where similar results were observed (Abdolvahabi *et al.*, 2016).

The total protein concentrations in goats exhibited a trend similar to that observed in serum albumin, which increased after parturition and from the beginning of the lactation period until the third week. Moreover, cows producing more milk have higher serum protein concentrations, and there was a very significant correlation (R^2=0.94) between serum protein concentration and the duration of the milk production phase (Bobbo *et al.*, 2017). However, we did not test the correlation between milk yield and serum protein content. Aminotransferase enzyme activity is needed for the synthesis of amino acids, which in turn make proteins. Milk proteins are found at a concentration of approximately 3.5 g/L in goats. Therefore, there is increased activity of the enzyme during the first weeks of lactation (Kaneko *et al.*, 1997).

Serum total protein concentrations in newborns (calves and lambs) are significantly affected by the intake of colostrum, but this phenomenon is not observed in kids. Serum total protein concentrations increased significantly at day one as compared with concentrations measured at 2 weeks of age in calves and in lambs; however, a significant increase ($P<0.05$) was not observed in kids (Nagyova *et al.*, 2016). The results of the previous study (Nagyova *et al.*, 2016) support our findings, since it shows there were no significant differences in serum total protein concentrations between 1 and 4 weeks of age. However, it is not clear what factors, other than the sampling protocols, caused such differences between kids, calves, and lambs. In addition, there is a lack of information regarding Aardi goats which makes such results of great importance to further our knowledge of this native breed of goats.

Our results also agree with previous studies that reported increased serum cholesterol concentrations during late pregnancy in goats (Sandabe *et al.*, 2004) and sheep (Mohammadi *et al.*, 2016) when compared to post-partum or non-pregnant ones. These changes were the result of normal endocrinological and physiological changes in pregnant animals (Watson *et al.*, 1993). Cholesterol is needed for normal functioning of the body (Shukla *et al.*, 2002), and it plays an essential role in cell membrane formation, hormone production, and the production of fat-soluble vitamins (Okonkwo *et al.*, 2010). A previous study (Sandabe *et al.*, 2004) found that Sahel pregnant goats have significantly higher serum cholesterol concentrations than non-pregnant ones. Furthermore, our results indicate the highest serum cholesterol concentrations in pregnant Aardi goats were at 4 weeks pre-parturition (130.6±6.1 mg/dL) and the lowest were after parturition (83.63±4.72 mg/dL). Differences in serum cholesterol concentrations from previous studies can be attributed to differences in breed and nutritional status (Khan *et al.*, 2013).

In the present study, serum cholesterol concentrations exhibited an increasing trend from the first week until the fourth week of age. This trend associated with serum cholesterol concentrations may be related to the high dietary intake of colostrum and milk from the mothers, since it was observed in kids (Abdolvahabi *et al.*, 2016) up to 4 weeks of age.

Serum urea concentrations are used to diagnose ketosis in goats, and pregnant goats with subclinical or clinical ketosis were reported to have higher serum concentrations of urea than goats without pregnancy ketosis (Vasava *et al.*, 2016). Although we did not perform any biochemical tests for subclinical ketosis, clinical ketosis was not detected. A previous study indicated no differences in serum urea concentrations between pregnant and non-pregnant Sahel goats that were reared under proper management and nutritional conditions (Waziri *et al.*, 2010). Our results showed a significant decrease ($P<0.05$) in Aardi serum urea concentrations starting 3 weeks pre-partum. A similar observation was reported (Castagnino *et al.*, 2015), showing that in multiparous Saanen and Oberhasli goat breeds in Brazil, a decrease in serum urea concentrations started much earlier, at 10 weeks pre-partum; although, results were not affected by breed differences.

Additionally, serum urea concentrations in Aardi goats were slightly lower than that reported in non-pregnant Raini goats of Iran (14.89–17.19 mg/dL) for all age groups, from 12 to 35 months of age (Sakha *et al.*, 2008). In non-pregnant Marwari goats in India, aged 1–2 years, serum urea concentrations were 14.15 mg/dL in moderate weather and 19.33 mg/dL during hot weather (Kour *et al.* 2014). In addition to the effects of ambient temperature, both nutrition and goat breed affect serum urea concentrations. This is because low nutrition levels decrease serum urea concentrations (Rondina *et al.*, 2005). Furthermore, it is important to note that some limitations might have contributed to our results, including the small sample size of goats and kids.

Decreased serum urea concentrations were reported in newborn kids. However, even after serum urea concentrations decreased from birth to 2 weeks of age, newborn Saanen goats showed significant increases until 12 weeks of age (Abdolvahabi *et al.*, 2016). Our results only indicated a significant difference ($P<0.05$) in serum urea concentrations at 4 weeks of age, as compared with the concentrations detected at 3 weeks of age. While we only have serum urea concentration data from kids up to 4 weeks of age, these results show a decreasing trend of urea in the first few weeks of life.

Conclusions: Under the conditions of this study, Aardi goats remained healthy during pregnancy and parturition, even with differences in metabolic profiles. We can use this baseline information, which has never been reported, to set parameters for Aardi goats and kids in central Saudi Arabia. Furthermore, this study indicated that the feeding regimen used, prevented pregnancy ketosis in all of the goats. Additional work is needed to analyze metabolic profiles throughout the entire pregnancy and

post-partum periods during different seasons in order to obtain more detailed values associated with this breed.

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Authors contribution: MA designed the experiment, collected and analyzed the blood samples, analyzed the data and wrote the manuscript and approved the final manuscript for submission.

REFERENCES

Abdolvahabi S, Zaeemi M, Mohri M, *et al.,* 2016. Age related changes in serum biochemical profile of Saanen goat kids during the first three months of life. Rev Med Vet 167:106-12.

Adam AAG, Hamza NB, Salim MAW, *et al.,* 2015. Genetic diversity among three goat breeds in Saudi Arabia using DNA markers. Global Vet 15:304-8.

Al-Hassan MJ, Mohamed HE, Alsamawi KA, *et al.,* 2016. The influence of pregnancy and lactation on plasma antioxidant status in Aardi goats. Int J Vet Res 2:32-5.

Al-Samawi KA, Al-Hassan MJ and Swelum AA, 2014. Thermoregulation of female Aardi goats exposed to environmental heat stress in Saudi Arabia. Indian J Anim Res 48:344-9.

Ashour G, Neama A, Ashmawy A, *et al.*, 2015. Blood hematology, metabolites and hormones in newborn sheep and goat from birth to weaning. Int J Adv Res 3:1377-86.

Bobbo T, Fiore E, Giansella M, *et al.*, 2017. Variation in blood serum proteins and association with somatic cell count in dairy cattle from multi-breed herds. Animal 31:1-11.

Castagnino D, Härter CJ, Rivera AR, *et al.,* 2015. Changes in maternal body composition and metabolism of dairy goats during pregnancy. R Bras de Zootec 44:92-105.

Contreras GA and Sordillo LM, 2011. Lipid mobilization and inflammatory responses during the transition period of dairy cows. Comp Immunol Microbiol Infec Dis 34:281-9.

El-Tarabany AA, 2012. Physiological changes in ewes conceived single or twins fetuses related with survivability of lambs. Arab J Nuc Sci Applic 45:1-11.

Herosimczyk A, Lepczynski A, Dratwa-Chalupnik A, *et al.,* 2011. Age-related changes of selected blood biochemical indicators in dairy calves during their first week of life. Folia Biol 59:25-30.

Kaneko T, Suzuki H and Takahashi T, 1987. Influences of cellular components and redox potential of liquid concentrated culture of *Lactobacillus bulgaricus* on acid-producing activity and viability. J Dairy Sci 70:1128-33.

Khan A, Rehman S, Imran R, *et al.,* 2013. Analysis of serum cholesterol level in goats breeds in Gilgit-Baltistan area of Pakistan. J Agric Sci Technol 3:302-6.

Kour G, Kataria N and Lawhale NS, 2014. Ambient temperature associated variations in serum urea and creatinine in Marwari goats. J Agric Vet Sci 7:15-8.

Lima AL, Moretti DB, Nordi WM, *et al.,* 2013. Eletrophoretic profile of serum proteins of goat kids fed with bovine colostrum *in natura* and lyophilized. Small Rum Res 113:278-82.

Manat TD, Chaudhary SS, Singh VK, *et al.,* 2016. Hematobiochemical profile in Surti goats during post-partum period. Vet World 9:19-24.

Mohammadi V, Anassori E and Jafari S, 2016. Measure of energy related biochemical metabolites changes during peri-partum period in Makouei breed sheep. Vet Res Forum 7:35-9.

Mishra A, Chatterjee US and Mandal TK, 2013. Induction of chronic renal failure in goats using cisplatin: a new animal model. Toxicol Int 20:56-60.

Nagyova V, Tothova C and Nagy O, 2016. The impact of colostrum intake on the serum protein electrophoretic pattern in newborn ruminants. J Appl Anim Res 45:498-504.

National Research Council (NRC), 2007. Nutrient Requirements of Small Ruminants: Sheep, Goats, Cervids, and New World Camelids. The National Academies Press. Washington, DC, USA.

Okonkwo JC, Omeje IS, Okonkwo IF, *et al.,* 2010. Effect of breed, sex and source within breed on the blood bilirubin, cholesterol and glucose concentrations of Nigerian goats. Pak J Nutr 9:120-4.

Presidency of Meteorology and Environment (PME), 2006. Meteorological data of Riyadh for the period 1985-2005. PME, Jeddah, Saudi Arabia.

Roche M, Rondeau P, Singh NR, *et al.,* 2008. The antioxidant properties of serum albumin. FEBS Lett 582:1783-7.

Rondina D, Freitas VJF, Spinaci M, *et al.,* 2005. Effect of nutrition on plasma progesterone levels, metabolic parameters and small follicles development in unstimulated goats reared under constant photoperiod regimen. Reprod Dom Anim 40:548-52.

Sakha M, Shamesdini M and Mohamad-zadeh F, 2008. Serum biochemistry values in Raini goat of Iran. Int J Vet Med 6:1-7.

Sandabe UK, Mustapha AR and Sambo EY, 2004. Effect of Pregnancy on Some Biochemical Parameters in Sahel Goats in Semi-arid Zones. Vet Res Commun 28:279-85.

Shukla V, Dutta P and Artz W, 2002. Camelina oil and its unusual cholesterol content. J Amer Oil Chem Soc 79:965-9.

van den Akker CH, te Braake FW, Schierbeek H, *et al.,* 2007. Albumin synthesis in premature neonates is stimulated by parenterally administered amino acids during the first days of life. Amer J Clin Nutr 86:1003-8.

Vasava PR, Jani RG, Goswami HV, *et al.,* 2016. Studies on clinical signs and biochemical alteration in pregnancy toxemic goats. Vet World 9:869-74.

Watson TDG, Burns L, Packard CJ, *et al.,* 1993. Effects of pregnancy and lactation on plasma lipid and lipoprotein concentrations, lipoprotein composition and post-heparin lipase activities in Shetland pony mares. J Reprod Fert 97:563-8.

Waziri MA, Ribadu AY, Abdullahi Y, *et al.,* 2010. Changes in the serum proteins, hematological and some serum biochemical profiles in the gestation period in the Sahel goats. Vet Arhiv 80:215-24.