NIGERIAN VETERINARY JOURNAL

ISSN 0331-3026

Nig. Vet. J., September 2017 **Vol 38 (3): 226-234.**

ORIGINAL ARTICLE

Effects of Dexamethasone on Liver Enzymes and Some Serum Electrolytes in Pregnant Yankasa Sheep and Sahel Goat

Yahi, D. [1]*; Ojo, N. A.[1] and Mshelia, G. D.[2]

[1]Department of Veterinary Physiology and Biochemistry, Faculty of Veterinary Medicine, University of Maiduguri, P.M.B 1069, Maiduguri, Nigeria. [2]Department of Theriogenology, Faculty of Veterinary Medicine, University of Maiduguri, P.M.B 1069, Maiduguri, Nigeria. *Corresponding author: Email: yahidauad@gmail.com; Tel No: +2348037811882

SUMMARY

Dexamethasone is usually prescribed concomitantly with other medications as anti-inflammatory and immunosuppressive agent and for management of respiratory distress syndrome. Concomitant usage of dexamethasone and other medications may alter electrolyte metabolism and increase the formation of potentially hepatotoxic reactive metabolites which can contribute to elevated liver enzymes. The role of dexamethasone in liver functions and electrolyte metabolism during pregnancy in Yankasa sheep and Sahel goat has not been determined. This study evaluated the effect of dexamethasone on the liver enzymes and to ascertain its role in electrolyte metabolism during pregnancy in Yankasa sheep and Sahel goat. Twenty four healthy adult animals comprising of 10 Sahel does and 2 bucks and 10 Yankasa ewes and 2 rams were used for this study. Pregnancies were achieved by natural mating after synchronization. Repeated dexamethasone injection was given at 0.25mg/kg body weight on days 1, 3 and 5 during first trimester; day 51, 53 and 55 during second trimester, and day 101, 103 and 105 during the third trimester. Blood samples were collected for sixteen weeks through the jugular vein. Serum samples collected were used for the analysis of Alanine amino transferase (ALT), Aspartate amino-transferase (AST), Alkaline Phosphatase (ALP) calcium (Ca^{2+}) Sodium (Na^{+}) and potassium (K^{+}) concentrations. Dexamethasone significantly ($P<0.05$) decreased AST, ALT, ALP and K^{+} levels in both species. However, Ca^{2+}, Na^{+} concentrations remained unchanged. The decreased levels of liver enzymes suggest that dexamethasone possess some hepato-protective properties and no interspecies difference in the liver response and mineral metabolism following dexamethasone treatment during gestation.

Key words: Dexamethasone, Electrolytes, Liver enzymes, Pregnancy, goat, Sheep.

INTRODUCTION

Small ruminants are widely distributed in the tropics and are considered as major livestock species in Africa (Peacock, 1996). They are increasingly becoming a primary source of dietary animal protein in Nigeria and contribute greatly to the Nigerian socio economic development (Gall, 1996). However, the profitability of sheep and

goats depends largely on their management and health (Lakpini, 2002). The herders will therefore usually do all within their powers using available resources to provide best management practice and health care services to ensure continuity of the business. The result of this is increased demand for health care and veterinary services. Dexamethasone is a commonly used drug in veterinary practice (Aliu, 2007).

Dexamethasone is a derivative of corticosteroids and has similar 21 carbon steroid skeleton as hydrocortisone (Pierre-louis, 2010; Aliu, 2007). Administration of dexamethasone is a common clinical practice especially in pregnant subjects (Hankinson *et al.,* 1999; Aliu, 2007; Pierre-Louis, 2010). In addition to its anti-inflammatory and analgesic use, dexamethasone is also employed in the treatment of pregnancy related metabolic diseases such as ketosis, pregnancy toxemia and mastitis (McDonald, 1990; Aliu, 2007), prenatal foetal lung development and maturation as well as management of neonatal diseases (Liggins and Howie, 1972; Christer, 1994). Unfortunately, the dexamethasone use has been associated with intra uterine growth foetal restriction (IUGR), decrease birth weight and placental weights in some animal models as well as humans (Mathews, 2000; Bloom *et al*., 2001; Kranendonk *et al*., 2006; Baisden *et al*., 2007; Yahi *et al*., 2017). Some authors have extrapolated that the adverse effects of dexamethasone can be counterbalanced by its benefits and that the benefits seem to outweigh the adverse effects or risk (Park *et al.,* 2002). Hence despite its adverse effects, dexamethasone is now on the World health Organization (WHO) list of essential medicine, as among the most important medications needed in a basic health care system (WHO, 2015). However, different species do not always respond to medicines in the same way due to differences in anatomy, metabolism and inherent pharmacokinetics.

One of the most important changes during pregnancy is the increase in metabolism, including minerals and electrolytes metabolism. For example greater amounts of calcium, potassium and sodium are needed for the developing bones, erythropoiesis and to provide nourishment to the growing foetus as well. Liver enzymes such as AST and ALT are widely distributed enzymes, which are found in many tissues and organs, with a particularly high activity in the liver (Zimmerman *et al.,* 1986). Evaluation of liver enzymes activities is of diagnostic importance in pregnant subjects (Seifi *et al*., 2007) and reports have shown an interspecies difference with respect to maternal leukocytic response (Yahi *et al*., 2016) and foetal response (Yahi *et al*., 2017) to dexamethasone treatment. The objective of this study was to investigate and compare effects of dexamethasone on serum liver enzymes and electrolytes in pregnant Yankasa sheep and Sahel goat.

MATERIALS AND METHODS

We adopted some aspects of the methods of Yahi *et al*. (2016) and Yahi *et al*. (2017) in our methodology.

A total of 24 adult healthy animals comprising of 10 Sahel does and 2 bucks and 10 Yankasa ewes and 2 rams were used for this study. Their known mean gestational lengths were 148.35 ± 1.50 days for Yankasa sheep and 148.33 ± 1.58 days for Sahel goats respectively (Rwuaan *et al*., 1993; Waziri *et al*., 2010). The animals were purchased from main livestock market and private farms in Maiduguri metropolis. The ages of the does ranged between 2 and 3 years and the bucks ranged from 2½ to 3 years, while that of the ewes and the rams were 3 to 3½ years old, based on dentition and breeding history (Dyce *et al.,* 1987). The does weighed between 22 to 25 kg and the bucks 29 kg and 32 kg. The ewes weighed between 33 to 37 kg; the weights of the rams were 40 to 45 kg. The body condition score (BCS) between 3.0 and 3.5

was maintained during the period of the experiment in all the animals. They were managed intensively in the University of Maiduguri Livestock research Farm and were acclimatized for six weeks before the commencement of the experiment. The feed rations consisted of wheat offal, beans husks and hay from groundnut leaves. Mineral salt licks and water were provided *ad libitu*m. During the stabilization period, the animals were treated with oxytetracycline LA (Introxin-200®, Interchiemie, Venray, Holland) at 20 mg/kg body weight I/M and ivermectin (paramectin®, Pharma Swede, Egypt) at 200 µg/kg body weight. The males and the females were initially kept in different pens until the time of service.

Estrus Synchronization

At the end of the acclimatization period, the animals were synchronized using cloprostenol (Estrumate®, Schering Trough Animal, Germany) at 250 µg given intramuscularly 11 - day interval, as described previously (Akusu and Egbunike, 1984). The females were teased with apronned males daily and all the females that came into estrus after the second treatment were allowed to be served naturally by the male. Days of estrus were recorded and considered as day 0 of the gestation. After successful synchronization and fertile mating, they were randomly separated into 4 groups of 5 each. The groups were as follows: Dexamethasone treated Sheep (DTS), Non dexamethasone treated Sheep (NDS), Dexamethasone treated goat (DTG) and Non dexamethasone treated goat (NDG). The non-treated groups served as control.

Dexamethasone Treatment

The animals in the dexamethasone treated group were administered dexamethasone (Dexaphan®, Pharma Pharmaceuticals, Swede-Egypt) intramuscularly at 0.25 mg/kg body weight on days 1, 3 and 5 during first trimester; days 51, 53 and 55 during second trimester, and days 101, 103 and 105 during the third trimester. The animals were observed for possible clinical changes throughout the period of the study. Their initial body weights, rectal temperatures, pulse rates and respiratory rates were recorded. This was continued at two weeks interval during the study (data not presented in this study). Pregnancies were later confirmed by failure to return to estrus and by ultrasonograhic examination.

Blood Sample Collection and Analysis

Five milliliters of blood samples were collected from day 0 from each animal in all groups and thereafter on biweekly basis for sixteen weeks through the jugular vein on the same day with minimal excitement prior to feeding. The blood samples of each animal were placed in sterile sample bottles without anticoagulant and the blood was allowed to clot. The serum was harvested and stored at -20^{o}C for the analysis of liver enzymes and serum electrolytes. Alanine amino transferase (ALT) and Aspartate amino-transferase (AST) levels were determined using methods described by Reitman and Frankel (1957) as modified by Wright *et al.* (1972), using Randox Laboratories kits. Alkaline Phosphatase (ALP) was determined using methods described by Babson *et al*. (1966). The serum concentrations of calcium (Ca^{2+}) were determined by method described by Lorentz (1982). Sodium (Na^{+}) and potassium (K^{+}) concentrations were determined by flame photometry according to the method described by Treitz (1994).

RESULTS

The changes in the values of liver enzymes (AST, AL) and ALP and serum electrolyte (Ca^{2+}, K^{+} and Na^{+} following prenatal dexamethasone treatments are presented in Tables 1 and 2. The results showed that AST, ALT and ALP levels were significantly ($p < 0.05$) lower in dexamethasone-treated pregnant dams in

TABLE I: Effects of dexamethasone on liver enzymes in pregnant Yankasa sheep and Sahel goats

Parameters	Groups	Sheep (N = 10)								
		Periods of observation (days)								
		0	14	28	42	56	70	84	98	112
AST(IU/L)	DTS	60.51±0.47	60.52±0.24	58.28±0.25	56.23±0.20[b]	50.37±0.30[b]	38.20±0.22[b]	34.30±0.31[b]	35.29±0.32[b]	32.32±0.19[b]
	NDS	60.50±0.52	60.50±0.26	58.29±0.29	54.47±0.55	53.56±0.45	53.40±0.38	52.70±0.44	50.40±0.38	50.52±0.44
ALT(IU/L)	DTS	35.29±0.41	35.28±0.31	33.35±0.25	34.22±0.15	32.71±0.24	30.53±0.30[b]	23.40±0.33[b]	22.24±0.48[b]	24.23±0.31[b]
	NDS	35.27±0.56	35.29±0.25	33.30±0.29	34.20±0.24	32.75±0.21	32.52±0.33	32.47±0.48	33.61±0.18	33.20±0.20
ALP(IU/L)	DTS	49.87±0.28	49.85±0.65	51.40±0.39	52.56±0.42[b]	53.35±0.30[b]	53.67±0.32[b]	54.20±0.23[b]	54.30±0.21[b]	54.54±0.38[b]
	NDS	49.88±0.24	49.88±0.43	51.50±0.25	55.45±0.60	56.33±0.38	56.69±0.58	57.30±0.28	57.87±0.50	58.50±0.39
Parameters	Groups	Goat (N = 10)								
		Periods of observation (days)								
		0	14	28	42	56	70	84	98	112
AST(IU/L)	DTS	58.38±0.32	58.46±0.34	58.46±0.24	58.43±0.42	45.34±0.22[b]	44.43±0.29[b]	42.31±0.31[b]	42.35±0.20[b]	42.34±0.33[b]
	NDS	58.42±0.35	58.45±0.33	58.45±0.23	58.41±0.32	57.65±0.22	57.50±0.48	58.37±0.35	58.40±0.20	57.34±0.31
ALT(IU/L)	DTS	33.64±0.36	33.88±0.45	33.60±0.25	34.38±0.20	34.33±0.38	24.33±0.32[b]	24.29±0.21[b]	24.30±0.34[b]	23.58±0.35[b]
	NDS	33.62±0.36	33.89±0.57	33.60±0.28	34.31±0.29	34.35±0.35	33.71±0.20	33.58±0.49	34.40±0.19	34.38±0.21
ALP(IU/L)	DTS	45.26±0.30	45.32±0.20	48.25±0.20	49.40±0.29	49.35±0.40	47.18±0.21[b]	48.31±0.37[b]	46.98±0.30[b]	41.35±0.32[b]
	NDS	45.26±0.31	45.34±0.29	48.28±0.42	49.50±0.23	49.37±0.38	51.92±0.41	58.19±0.24	58.86±0.35	59.31±0.28

DTS = Dexamethasone treated sheep; NDS = Non dexamethasone treated sheep (Control); DTG = Dexamethasone treated goat; NDG = Non dexamethasone treated goat (Control); AST=Aspartate amino transferase; ALT=Alkaline amino transferase; ALP=Alkaline phosphatase

[b] =Significant ($p<0.05$) decrease compared to respective control group

TABLE II: Effects of dexamethasone on some serum electrolytes in pregnant yankasa sheep and sahel goats

Parameters	Groups	Sheep (N = 10)								
		Periods of observation (days)								
		0	14	28	42	56	70	84	98	112
Ca^{2+}(mmol/L)	DTS	8.33±0.6	8.35±0.31	8.34±0.42	8.33±0.35	8.35±0.35	8.34±0.29	8.36±0.20	8.34±0.31	8.36±0.23
	NDS	8.34±0.5	8.34±0.30	8.35±0.35	8.33±0.36	8.34±0.32	8.33±0.21	8.35±0.19	8.34±0.30	8.35±0.33
K^{+}(mmol/L)	DTS	4.25±0.29	4.25±0.28	4.27±0.19	4.25±0.24	4.23±0.20	3.89±0.27[b]	3.85±0.35[b]	3.88±0.36[b]	3.97±0.28[b]
	NDS	4.25±0.28	4.26±0.20	4.26±0.25	4.26±0.23	4.24±0.29	4.25±0.28	4.25±0.30	4.24±0.30	4.27±0.21
Na^{+}(mmol/L)	DTS	137.20±1.01	138.10±1.11	138.1±1.07	137.30±1.02	137.30±1.06	138.20±1.05	138.12±1.10	137.01±1.01	137.40±1.10
	NDS	137.40±1.04	137.20±1.12	138.3±1.05	137.30±1.04	137.40±1.04	138.10±1.03	137.11±1.10	137.04±1.05	137.50±1.07
Parameters	Groups	Goat (N = 10)								
		Periods of observation (days)								
		0	14	28	42	56	70	84	98	112
Ca^{2+}(mmol/L)	DTG	8.20±0.40	8.23±0.20	8.22±0.20	8.23±0.18	8.21±0.22	8.22±0.27	8.20±0.22	8.23±0.19	8.21±0.24
	NDG	8.22±0.20	8.24±0.18	8.20±0.32	8.23±0.17	8.22±0.15	8.22±0.26	8.21±0.20	8.23±0.19	8.23±0.24
K^{+}(mmol/L)	DTG	4.51±0.19	4.52±0.33	4.53±0.25	4.52±0.30	3.60±0.28[b]	3.72±0.20[b]	3.90±0.34[b]	3.98±0.28[b]	3.96±0.25[b]
	NDG	4.51±0.17	4.51±0.31	4.54±0.24	4.54±0.35	4.52±0.31	4.53±0.19	4.52±0.26	4.52±0.21	4.55±0.0.38
Na^{+}(mmol/L)	DTG	141.0±1.10	142.0±1.10	142.2±1.06	141.11±1.10	142±1.12	141.30±1.04	142.1±1.0	141.20±1.10	141.20±1.12
	NDG	141.12±1.0	142.20±1.10	142.0±1.04	141±12±1.10	142.0±1.11	142.40±1.13	142.0±1.0	142.10±1.20	141.30±1.05

DTS = Dexamethasone treated sheep; NDS = Non dexamethasone treated sheep (Control); DTG = Dexamethasone treated goat; NDG = Non dexamethasone treated goat (Control);

[b] =Significant ($p<0.05$) decrease compared to respective control group

both species compared to their respective control groups. The effects were mainly observed from mid-gestation and extended to day 112 of gestation. The Ca^{2+} concentrations remained unchanged in both groups while the K^+ levels were significantly lower from day 70 of gestation in dexamethasone-treated pregnant Yankasa sheep compared to control. Similar trend was observed in goats, except that Potassium (K^+) decrease occurred earlier (day 56) than that in sheep (day 70). However, Ca^{2+}, and Na^+ concentrations remained unchanged in both groups.

DISCUSSION

Glucocorticoid helps to maintain cell membrane integrity and prevents AST leakage into the general circulation (Adams, 2001). This fact may explain the observed lower AST and ALT concentrations in dexamethasone treated groups compared to the control in both sheep and goats. ALT and AST evaluation is part of analyzing biochemical parameters analyzed in pregnant subjects (Seifi *et al*., 2007). The significant decrease in ALT and AST observed in this study suggests reduction in liver damage or breakdown (Jorritsma *et al*., 2004), which implies liver friendly and beneficial effect. Therefore dexamethasone may be used as prophylactic treatment before administering drugs with hepatotoxic potential like pain relief medications, anti-seizure medications and some classes of antibiotics such as sulfonamides and nitrofurantoin during gestation. The decrease in liver enzymes observed in this study is similar to findings in previous study by Halil *et al*. (2006) who reported decrease in liver enzymes and reduction in liver damage due to bile duct ligation in rats

The decrease in ALP in dexamethasone treated groups in both species on the other hand, may be due to placental malfunctions as established in previous studies (McDonald *et al*., 2003; Ain *et al*., 2005; Hewitt *et al*., 2006; Sanhu, 2013; Yahi *et al*., 2017). Based on the data obtained in the present study, the liver function markers were not elevated, rather decreased, which implies liver friendly and beneficial effect of dexamethasone and that livers were not damage by the dexamethasone treatments. Therefore, the decrease in the ALP concentration in the dexamethasone treated groups in both species may be due to placental malfunctions. This is because ALP is a product mainly from liver and placenta (Nduka, 1997; Tietz, 1999).

The mechanism underlying the decrease in K^+ is not clear; however, the decrease could be due to increased urinary K^+ excretion without corresponding effects on sodium or calcium excretion. A similar observation was made by Johnson *et al*. (2009) in rats where dexamethasone injection produced 70% increase in urinary K^+ excretion. The lack of effects on Na^+ and Ca^{2+} in both species on the other hand could be due to lack of mineralocorticoid activity of dexamethasone (Trine *et al.*, 2008; Pierre-Louis, 2010). Dexamethasone is known to have virtually no mineralocorticoid effect, but remains a potent anti-inflammatory and analgesic glucocorticoid with broad significant physiological and therapeutic uses (Trine *et al.*, 2008; Pierre-Louis, 2010).

CONCLUSION

This study has further confirmed that dexamethasone decreases liver enzymes and potassium levels during pregnancy in sheep and goat but has no effects on calcium and sodium metabolism. The reduction in liver damage markers is probably one of the beneficial effects of dexamethasone. Unlike previous reports which shown an interspecies difference with respect to maternal leukocytic and foetal responses to dexamethasone treatment, there is no difference in the liver response and mineral metabolism between pregnant sheep and goat following dexamethasone treatment.

ACKNOWLEDGEMENTS

The Authors wish to acknowledge the technical assistance of Mrs. Rhoda Genesis of the Chemical Pathology Department, University of Maiduguri Teaching Hospital (UMTH) and the animal care taker Mr. Bello Usman for their contributions. We also want to appreciate University of Maiduguri Management for partly funded the research work.

REFERENCES

ADAMS, H.R. (2001): Veterinary Pharmacology and Therapeutics, 8th ed., *Ames Publisher: Iowa State Univ.* Pp 77 - 81

AIN, R.L., CANHAM, N., and SOARES, M.J. (2005): Dexamethasone-induced intrauterine and placenta growth restriction and impacts on insulin-like growth factor-II and the Akt signaling pathway. *J Endocrinol* **18**(4):52 – 56.

AKUSU, M. O. and EGBUNIKE, G. N. (1984): Fertility of the West African Dwarf goat in its native environment following prostaglandin F_2- alpha induced estrus. *The Veterinary Quarterly Journal*, **6** (3)**:** 173-176.

ALIU, Y.O. (2007): Endocrine Pharmacology. In: *Veterinary Pharmacology by Aliu, 1st edition. Tamaza Publishing Company Ltd, Zaria*, 304 – 305.

BABSON, L.A., GREELEY, S. J., COLOMANN, C.M. and PHILIPS, G.D. (1966): Serum alkaline phosphatase determination. *American Journal of Clinical Biochemistry.**12:482-490***.

BAISDEN, B., SONNE, S., JOSHI, R.M., GANAPATHY, V. and SHEKHAWAT, P. S. (2007): Antenatal dexamethasone treatment and changes in gene expressions in Murine placenta; *Placenta* **28**: 1082-1090.

BLOOM, S.L., SHEFFIELD, J.S., MCINTIRE, D.D. and LEVENO, K.J. (2001): Antenatal dexamethasone and decreased birth weight. *Obstet Gynecol* **97**: 485-490.

CHRISTER, B. L. (1994): Reports on the Consensus Development conference on pregnancy. *J reprod. Fertic* **29**:409-413.

DYCE, K. M., SACK, W. B. and WENSING, G. T. (1987): Text book of Veterinary Anatomy, 3rd edition; *W.B.Saunders Co., Harcourt, Philadelphia* USA; Pp 675 - 677.

GALL, C. (1996): Goat breeds of the world, OTA/ CTA. *Weikensheim: Margaf Verlay, Germany, 1st edition,* Pp.47-69

HALIL, E., HAYRETTIN, O., HULYA, O. and HUSEYIN, B. (2006): Dose-related effects of dexamethasone on liver damage due to bile duct ligation in rats. *World J Gastroenterol* **12**(33): 5379–5383

HANKINSON, S. E., WILLETT, W, C., MICHAUD, D.S., MANSON, J.E., COLDDITZ, G.A., LONGCOPE, C., ROSNER, B. and SPEIZER, F.E. (1999): Plasma prolactin levels and risk factors of breast cancer in postmenopausal women. *International journal of cancer* **91**:629-634.

HEWITT, D.P., MARK, P.J. and WADDELL, B. J. (2006): Glucocorticoids prevention of normal increase in placental vascular endothelial growth factor expression and placental vascularity during late pregnancy in rats. *Endocrinol* **14**(7):55-68.

JOHNSON, M. B., KAREN, T. and RALPHA, D. (2009): Effect of Dexamethasone on renal electrolyte excretion in adrenalectomized rats. *J. Clin. Endocrinol. Metbol.* **111**(3): 156-188

JORRITSMA, R., THANASAK, J., HOUWELING, M., NOORDHUIZEN, J.P., and MÜLLER, K.E. (2004): Effects of a single dose of dexamethasone-21-isonicotinate on the metabolism of heifers in early lactation. *Vet Rec.* ***155****: 521–523.*

KRANENDONK, G., HOPSTER, H., FILLERUP, M., EKKEL, E.D., MULDER, E.J. and TAVERNE, M.A. (2006): Cortisol administration to pregnant sows affects novelty-induced locomotion, aggressive behaviour, and blunts gender differences in their offspring. *Journal of Hormonal Behaviour* **49**: 663-672.

LAKPINI, C., A. M. (2002): Management of sheep and goats: *Proc. of small ruminant traditional production workshop, NAPRI/ABU,* Shika, Nigeria.

LIGGINS, G. C. and HOWIE, R. N. (1972): A controlled trial of antepartum glucocorticoid treatment for prevention of the respiratory distress syndrome (RDS) in premature infants, *Pediatrics* **50**(6):317–322.

LORENTZ, K. (1982): Improved determination of serum calcium with 2-cresolphthalein complexion. *Clin. Chem. Acta.* **126**: 327-334.

MATTHEWS, S.G. (2000): Antenatal glucocorticoids and programming of the developing CNS. *Journal of Pediatric Research* **47**: 291-300

MCDONALD, I.F. (1990): Adrenal cortex. In**:** Veterinary Endocrinology and Reproduction by McDonald I.E, 3rd edition, *Lea and Febiger Co., Inc. Philadelphia, Beilliere, Tindal, London; Pp* 191-199

MCDONALD, T.J., FRANKO, K.L., BROWN, J.M., JENKINS, S.L., NATHANIELSZ, P.W. and NIJLAND, M.J. (2003): Dexamethasone in the last week of pregnancy causes fetal growth retardation but not adult hypertension in rats. *Journal of the Society for Gynecologic Investigation* **10**:469–473.

NDUKA, N. (1997): Clinical Biochemistry for Students of Chemical Pathology. 1st ed. *Longman,* Lagos, Nigeria; Pp. 122-123

PARK, Y.B., CHOI, H.K., KIM, M.Y., LEE, W.K., SONG, J., KIM, D.K. and LEE, S.K. (2002): Effects of antirheumatic therapy on serum lipid levels in patients with rheumatoid arthritis: a prospective study**.** *Am J Med.* **113:**188-193.

PEACOCK, C. (1996): Improving goat production in the tropics: A Manual for developing workers. *Farm-Africa and Oxfam*, U.K and Ireland, Pp 1-20.

PIERRE-LOUIS, T. (2010): Anti-inflammatory agents, In: Merck Veterinary Manual, 10th ed., Synthia, M.K., (ed.), *Merck and Co., Inc., White House Station, N.J. U.S.A. Pp* 2313-2328.

RWUAAN, J.S., MAMMAN, B. A., CHAUHAN, F. S. and SIVACHELVAN, M.N. (1993): Blood glucose levels of some local breeds of sheep and goats in Borno State, Nigeria: their implications on reproductive performances. *J. Prod. Res. 13(1):13-19*

SANHU, S.H. (2013): Essentials of Veterinary Pharmacology and Therapeutics, 2nd edition, *Kalyani Publishers Ltd, New Delhi, India;* Pp 776.

SEIFI, H.A., GORJIDOOZ, M., MOHRI, M., DALIRNAGHADEH, B. and FARZANEH, N. (2007): Variations of energy-related biochemical metabolites during transition period in dairy cows. Comp *Clin Pathol.* ***16****: 253–258.*

TREITZ, N.W. (1994): Fundamentals of clinical chemistry with clinical correlation; *1st edition.* Balliere *Tindall Ltd., UK. Pp 23 - 34.*

TIETZ, N.W. (1999): Textbook of Clinical Biochemistry, 3rd ed., *Philadelphia, PA, W.B. Saunders, Pp 327-350*

TRINE, H.M., RANDI, S.B., SAREN, R.P. and LARS, O. (2008): Mechanism of Dexamethasone mediated inhibition of Toll-like receptors signaling induced by *Neisseria miningididis* and *Streptococcus prenumonae. Infect Immum* **76**(1):189-197.

WAZIRI, M. A., RIBADU, A. Y. and 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.

WHO (2015): 19th World Health Organization (WHO) Model List of Essential Medicines, *WHO/19: LEM/04-2015.*

WRIGHT, P.J., LEATHERWOOD, P.D. and PLUMMER, D.T. (1972): Enzymes in Rats: Alkaline p hosphatase. *Enzymologia,* **42**; 317-327.

YAHI, D., OJO, N.A., MSHELIA, G.D. and MAINA, V. A. (2016): Comparative studies on the effects of dexamethasone on plasma lucose and lipid profiles in pregnant Yankasa sheep and Sahel goats in Maiduguri, Nigeria; *Vom Journal of Veterinary Science.* **11**: 73 – 79.

YAHI, D., OJO, N.A., MSHELIA, G.D. and MAINA, V. A. (2017): Comparative effects of dexamethasone on placental and foetal organ weights and some linear body measurements in Yankasa sheep and Sahel goats. *Sokoto Journal of Veterinary Sciences* **15**(1): 49-56.

ZIMMERMAN, H.J., DUJOVNE, C.A. and LEVY, R. (1986): Correlation of serum levels of two transaminases with tissue levels in six vertebrate species. *Comp Biochem Physiol*. **25:** 1081–1089.