



*Original Research*

## Serum Ionized Calcium and Macro Minerals Levels during Peripartum Period in Berari Goat

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### Abstract

The aim of the study was to find the levels of serum ionized calcium and some macro-minerals during peripartum period in Berari goat. Twelve advanced pregnant Berari goats were used for the study. Blood samples were collected on -14 day and -7 day before expected date of kidding and subsequently on the day of kidding (0<sup>th</sup> day), 7<sup>th</sup>, 14<sup>th</sup> and 21<sup>th</sup> day postpartum. Serum samples were collected for estimation of ionized calcium (iCa), total calcium, phosphorous and magnesium. Serum ionized calcium increased significantly from the day of kidding through 7<sup>th</sup>, 14<sup>th</sup> and 21<sup>st</sup> day postpartum with mean reference range of 4.19 ± 0.18 to 4.89 ± 0.16 mg/dl during peri-partum period in Berari goat. These values are almost half of the value reported for total calcium. Serum total calcium shown increasing trend through day 14<sup>th</sup>, 7<sup>th</sup> prepartum, day of kidding (0<sup>th</sup> day), 7<sup>th</sup>, 14<sup>th</sup> and 21<sup>st</sup> postpartum. Serum Phosphorus has shown increasing trend during entire peri-partum period. While magnesium has shown lowest value on 7<sup>th</sup> day postpartum without any specific trend. There was significant ( $p < 0.05$ ) positive correlation between levels of ionized calcium and total calcium and magnesium during peripartum period in Berari goat.

**Key words:** Berari Goat, Ionized Calcium (iCa), Macromineral and Peripartum Period

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### Introduction

Berari is recently recognized as 23<sup>rd</sup> goat breed of India, a breed of Vidarbha region of Maharashtra, is low yielding prolific meat breed thriving well in tropical, wet and dry climate. Three weeks before and three weeks after parturition the period as marked by several metabolic alterations and adaptation to new physiological status of the animal consider very critical called as transition period (Araújo *et al.*, 2014).



Level of plasma calcium during different physiological stages may vary (Shappel *et al.*, 1987 and Goff *et al.*, 1989). Goats metabolize calcium more efficiently during early lactation when calcium is drained in the milk. When serum calcium levels are decreased, usually less than 6 mg/dl (normal range 8-12 mg/dl) commonly known as milk fever. Although it is generally accepted that ionized calcium is the metabolically active form in the extracellular fluid, it is seldom measured. The measurement of free calcium is clinically more useful. The advantage to measuring ionized Ca is that it tends to be less variable than total plasma Ca (Szenci *et al.*, 1994.). The Ion Selective Electrode (ISE) method currently used for the estimation of electrolytes is the most accurate and rapid method for ionized calcium estimation. Magnesium involved in many physiological functions such as activation of various enzyme system (Romani and Scarpa, 2000). Magnesium plays a key role as an extracellular ion for nerve transmission. Hypomagnesaemia (tetany) occurs during the early stages of lactation in goats. Reproductive problems such as low first service conception rates and silent heat have been related to wide Ca:P ratio and to phosphorus deficiencies.

### Materials and Methods

Twelve advanced pregnant Berari goats aged between 2 to 5 years and body weight ranging between 28-30 kg were selected from Berari Goat and Deccani Sheep Research, Demonstration and Training Centre, Bargaon (Manju), MAFSU, Akola, Maharashtra. Blood samples were collected from the jugular vein puncture during morning hours on 14day and 7day before expected date of kidding and subsequently on the day of kidding (0<sup>th</sup> day), 7<sup>th</sup>, 14<sup>th</sup> and 21<sup>th</sup> day postpartum in clot activator sterilized tubes. Clear serum was separated by centrifugation. Serum macro minerals *viz.* total calcium, phosphorous and magnesium were estimated by using biochemical semi auto analyzer and standard kits supplied by AGD biomedical. Serum ionized calcium (iCa) was estimated by Electrolyte Analyzer by using Ion Selective Electrode (ISE).

### Statistical Analysis

Analysis of variance of the data was done by using Completely Randomized Design (CRD) and to study relationship correlation coefficient was calculated according to Snedecor and Cochran (1994).

### Results and Discussion

Mean  $\pm$  SE levels of ionized calcium, total calcium, phosphorus and magnesium during peripartum period in Berari goat is shown in Table 1 and correlation of iCa with these macro minerals during peripartum period in Berari goat is presented in Table 2.

### Total Calcium (tCa)

The results show that, on the day of kidding (0<sup>th</sup>day) 8.19 $\pm$ 0.18 mg/dl value was recorded. The lowest value of 7.40 $\pm$ 0.14 mg/dl was obtained on the 14<sup>th</sup> day of prepartum and highest value of 9.99 $\pm$ 0.17 mg/dl on 21<sup>st</sup> day of postpartum. The total calcium level was increased from day 7<sup>th</sup> day prepartum to 21<sup>st</sup> postpartum.

The level of total calcium during prepartum period ranged between  $7.40 \pm 0.14$  to  $8.03 \pm 0.13$  mg/dl, on the day of kidding (0<sup>th</sup> day)  $8.19 \pm 0.18$  and during postpartum period ranged between  $8.95 \pm 0.14$  to  $9.99 \pm 0.17$  mg/dl. Serum total calcium level on 14<sup>th</sup> day prepartum showed significant ( $p < 0.05$ ) increased on 7<sup>th</sup> day before kidding and remained almost similar on the day of kidding (0<sup>th</sup> day). After kidding total calcium concentration showed significant increased through day 7<sup>th</sup>, 14<sup>th</sup> and 21<sup>st</sup> of postpartum. Total calcium has shown steady increased from day 7 prepartum to day 21<sup>st</sup> postpartum throughout the experimental period. Gurgoze *et al.* (2009) observed similar trend of calcium level during prepartum and postpartum period in Awassi ewes. However, Talawar *et al.* (2016) reported significant ( $P < 0.05$ ) reduction in blood serum calcium concentrations in the group of pregnant ewes as compared to control and postpartum group. The levels obtained in present study were agreement with the results reported by Azab and Abdel- Maksoud, (1999); Iriadam, (2007), Soares *et al.* (2018) in goats and Teleb *et al.* (2014) and Sharma *et al.* (2015) in ewes. The decrease in calcium concentration at late gestation could be attributed to increased demand for calcium for mineralization of foetal skeleton and also owing to their supply to the foetal tissue to meet out the increased demand of growing foetus reported by Talawar *et al.* (2016). Kaushik and Bugalia (1995) reported drop in circulatory concentration of calcium before and at kidding are consequential to mammary drain in colostrum as well as reduced dietary intake and calcium absorption in gut.

**Table 1:** Mean  $\pm$  SE levels of ionized calcium and macro-minerals during peripartum period in Berari goat

Parameter	Prepartum Period		Day of Kidding	Postpartum Period		
	14 <sup>th</sup> Day	7 <sup>th</sup> Day	0 <sup>th</sup> Day	7 <sup>th</sup> Day	14 <sup>th</sup> Day	21 <sup>st</sup> Day
Total Calcium (mg/dl)	$7.40^{d \pm 0.14}$	$8.03^{c \pm 0.13}$	$8.19^{c \pm 0.18}$	$8.95^{b \pm 0.14}$	$9.76^{a \pm 0.11}$	$9.99^{a \pm 0.17}$
Ionized Ca (mg/dl)	$4.43^{bc \pm 0.14}$	$4.50^{abc \pm 0.14}$	$4.19^{c \pm 0.18}$	$4.52^{abc \pm 0.13}$	$4.62^{ab \pm 0.13}$	$4.89^{a \pm 0.16}$
Phosphorus (mg/dl)	$4.70^c \pm 0.15$	$5.24^{c \pm 0.28}$	$5.98^b \pm 0.20$	$6.54^b \pm 0.24$	$7.42^a \pm 0.23$	$7.76^a \pm 0.13$
Magnesium (mg/dl)	$2.59^b \pm 0.11$	$3.24^a \pm 0.18$	$3.12^a \pm 0.23$	$2.41^b \pm 0.14$	$3.29^a \pm 0.15$	$3.38^a \pm 0.17$

Means with common superscript does not differ significantly

**Table 2:** Correlation of ionized calcium with macro-minerals during peri-partum period in Berari goat

	iCa	tCa	Mg	P
Ica	1	0.536	0.48	0.159
tCa		1	0.268	0.002
Mg			1	0.382
P				1

### Ionized Calcium (iCa)

The ionized calcium concentration on the day of kidding (0<sup>th</sup> day)  $4.19 \pm 0.18$  mg/dl value was recorded. Serum ionized calcium level on 14<sup>th</sup> day prepartum showed significant ( $p < 0.05$ ) increased on 7<sup>th</sup> day before kidding. The values decreased significantly ( $p < 0.05$ ) on the day of kidding (0<sup>th</sup> day). After kidding ionized calcium concentration showed significant increased through day 7<sup>th</sup>, 14<sup>th</sup> and 21<sup>st</sup> of postpartum. Ionized

calcium (iCa) level recorded lowest on the day of kidding whereas highest on 3<sup>rd</sup> week after post-partum. Serum iCa level ranged between  $4.19 \pm 0.18$  to  $4.89 \pm 0.16$  mg/dl during prepartum and postpartum period in Berari goat. The level of iCa recorded in Berari goat in our study is almost half of the level of total calcium recorded, similar finding is also recorded by Caprita *et al.* (2013) in broiler chickens. Riond *et al.* (1995) reported average serum Ca<sup>2+</sup> concentrations 52% of those of total calcium. Belonje (1976) reported ionized calcium in lactating ewes and in day old suckling lamb were  $4.25 \pm 0.49$  mg/100 ml and  $4.47 \pm 0.65$  mg/100 ml respectively. Dauth *et al.* (1984) pointed out an importance of ionized calcium estimation for veterinary surgeons and other people involved in the diagnosis and treatment of milk fever. The analysis is easy, cheap, instantaneous and reliable as compared with total calcium. Sava *et al.* (2005) reported that serum iCa reflect true calcium status of body in health and diseased condition. They suggested that in human being the Ca<sup>++</sup> levels are independent of serum protein status. However, Agnes *et al.* (1993) reported that serum pH decided the concentration of ionized calcium as it is negatively correlated with ionized calcium. Ballantine and Herbein (1991) studied levels of ionized calcium in Jersey and Holsteins cows during different stage of lactation. They reported that Jersey cows had lower total calcium (7.47mg/dl) and ionized calcium (4.25mg/dl) than Holsteins cows (8.10 and 4.66 mg/dl). On day of calving the levels of iCa in Jersey cows are in comparable with our results on the day of kidding (0<sup>th</sup> day) in Berari goat. Changes in the level of ionized calcium may indicate the contribution of integrated hormonal response occurring during day of kidding in the goat. Tan *et al.* (1972) also reported decreased of the ionic calcium with the progress of pregnancy in women.

In present study the levels of ionized calcium increased significantly ( $p < 0.05$ ) from day 7<sup>th</sup>, 14<sup>th</sup> and 21<sup>st</sup> postpartum. However in contrast to our study in Berari goat, Riond *et al.* (1995) reported significant decrease level of serum ionic calcium during day 1 and day 2 postpartum in Brown Swiss and HF dairy cows. Mean plasma ionized calcium during early lactation in our study is in agreement with the levels ( $4.25 \text{ mg} \pm 0.49 / 100 \text{ ml}$ ) reported by Belonje, (1976) in lactating ewes. The literature regarding the level of serum ionized calcium during peripartum period in goat is scanty. Some workers have studied the levels of ionized calcium in other animals during pregnancy and lactation.

### Phosphorous (P)

On the day of kidding (0<sup>th</sup> day) the phosphorous concentration value of  $5.98 \pm 0.20$  mg/dl was recorded. The lowest value recorded on 14<sup>th</sup> day of prepartum and highest values recorded on 21<sup>st</sup> day of postpartum. The levels of phosphorus increased steadily from 14<sup>th</sup> day pre-partum to 21<sup>st</sup> day postpartum during peripartum period in Berari goat. The values of prepartum in comparison with day of kidding and subsequently on the day postpartum differ significantly ( $p < 0.05$ ). From the 7<sup>th</sup> day onwards it was increased significantly up to 14<sup>th</sup> day postpartum. Phosphorous concentration ranged between ( $4.70 \pm 0.15$  to  $7.76 \pm 0.13$  mg/dl) during

peripartum period in Berari goat. This range is slightly higher than the values recorded by Krajnicakova *et al.* (2003) in goat. Our result shows highest concentration of phosphorous on 21<sup>st</sup> day post-partum. Similar findings recorded by Tanritanir *et al.* (2009) in Sirt hair goat, Sansom *et al.* (1982); Ozyurtul *et al.* (2007) in ewes and Shinde and Sankhyam (2007) in goat. Alacam *et al.* (2008) reported lowest phosphorous concentration on 20<sup>th</sup> day post-partum in cattle. The trend of phosphorus has showed steady increase from 14<sup>th</sup> day prepartum up to 21<sup>st</sup> day post-partum. This might be due to maternal bone resorption of available phosphorus to the fast growing foetus inside the uterus for skeleton mineralization. The ever increasing demand of phosphorous by fast growing foetus could be fulfilled by absorbing available phosphorous from circulation or reabsorption from the bones of dam. As dam prioritize the fetus rather than herself (Gurgoze *et al.*, 2009) and also may be due to increase in metabolic process during early lactation, hormonal response in postpartum. However, Krajnicakova *et al.* (2003) reported non-significant differences in phosphorus levels at the different stages of growth, reproduction, pregnancy and lactation in goat.

### Magnesium (Mg)

On the day of kidding (0<sup>th</sup> day) 3.12±0.23 mg/dl value of magnesium concentration was recorded. Serum Mg concentration was lowest on 7<sup>th</sup> day postpartum and highest values on 21<sup>st</sup> day post-partum in Berari goat. Serum magnesium showed significant ( $p < 0.05$ ) increased on 7<sup>th</sup> day of prepartum and on the day of kidding then the level slightly decreased on 7<sup>th</sup> day of postpartum. The levels of Mg show non-significant increasing trend after 7<sup>th</sup> day through day 14<sup>th</sup> and 21<sup>st</sup> postpartum. Similar trend was also obtained for phosphorous levels in our study in Berari goats. The values of serum Mg increased significantly ( $p < 0.05$ ) from day 14 pre-partum to day of kidding (0<sup>th</sup> day). After kidding Mg concentration increased but this increase was statistically non-significant. Our finding corroborated with the values reported by Ozyurtul *et al.* (2007); Sharma *et al.* (2015) in ewe, Kulcu and Yur (2003) in cow and Shinde and Sankhyam (2007) in goat. The present results are not in agreement with the report of Sansom *et al.* (1982), they reported plasma Mg concentration were higher during last 3<sup>rd</sup> week of pregnancy but decreased at lambing and for 3<sup>rd</sup> weeks after lambing in ewes. Azab and Abdel-Maksoud (1999) recorded plasma Mg significantly ( $P < 0.05$ ) increased at 4 and 3 weeks before parturition and decreased ( $P > 0.05$ ) at 2 and 1 weeks before parturition. This decrease was significant ( $P < 0.05$ ) on the day of parturition in goats. Boudebza *et al.* (2016) reported highest Mg level in late gestation than on early lactation and during dry periods in ewes. Brenner and Seidel, (1976) in ewes and Talawar *et al.* (2016) in goat reported no significant change in mineral concentrations at the time of parturition. There was transient increased of Mg<sup>2+</sup> concentrations than the total Mg during periparturient period signifies the metabolic importance of magnesium concentration (Riond *et al.*, 1995). The change could be carried by physiochemical alteration from mother to the fetus as the magnesium subsequently required for normal skeletal development in fetus while it is constituent of milk in dam.

### Correlation of Ionized Calcium with Macro Minerals during Peripartum Period in Berari Goat

There was significant ( $p < 0.05$ ) positive correlation ( $r = 0.536$ ) between ionized calcium and total calcium. Also significant ( $p < 0.05$ ) positive correlation between ionized calcium and magnesium ( $r = 0.480$ ). Total calcium has shown significant ( $p < 0.05$ ) positive relationship with magnesium ( $r = 0.268$ ) and non-significant positive correlation with phosphorous ( $r = 0.002$ ). Serum magnesium level has shown positive significant ( $p < 0.05$ ) correlation with phosphorous ( $r = 0.382$ ) during peripartum period in Berari goat.

### Conclusion

The levels of ionized calcium and macrominerals viz. total calcium, Mg and P were estimated during the peri-partum period of the Berari goat. The main objective of the study was to find out the levels of iCa during the peri-partum period of these goats by using ion selective electrode (ISE). The ISE is the most convenient, accurate and reliable method for the estimation iCa. In our study the iCa levels were almost half the levels of the total calcium. This indicates that the half of the calcium in the blood is in ionized form i.e. biologically active form in these animals serum ionized calcium increased significantly from the day of kidding through 7<sup>th</sup>, 14<sup>th</sup> and 21<sup>st</sup> day postpartum. Serum phosphorus shown increasing trend through day 14<sup>th</sup>, 7<sup>th</sup> prepartum, day of kidding (0<sup>th</sup> day), 7<sup>th</sup>, 14<sup>th</sup> and 21<sup>st</sup> post-partum. Serum Mg concentration lowest on 7<sup>th</sup> day postpartum and highest values on 21<sup>st</sup> day postpartum without any specific trend. There was significant positive correlation between serum ionized calcium and total calcium and magnesium level during peri-partum period in Berari goat.

Considering the biological importance of ionized calcium and to establish its normal reference range and cut off value of iCa for the accurate diagnosis of various metabolic disorders during peri-partum period in these goats, it is necessary to study this parameter through entire gestation period with more number of samples along with total calcium, total protein, pH and vitamin D status in healthy and animals with subclinical and clinical hypocalcaemia.

### References

1. Agnes, F., Sartorelli, P., Bisso, MC and Dominoni, S. 1993. Ionized calcium in calf serum: relation to total serum calcium, albumin, total protein and pH. *J. Vet. Med. A.* 40:605-608.
2. Alacam, E., Tuncer S D., Salmanoglu, M.R., Kucukersoan, S., Kucukersan M K and Ozluer, A. 2008. The effects of nutritionally unbalanced diet on some blood and postpartum fertility parameters in dairy cows. *Turk. J. Vet. Anim. Sci.* 32(2):99-106.
3. Araujo, C. A. S. C., Nikolaus, J. P., Morgado, B. M. Monteiro, F.A.M.L. Rodrigues, P.C. Soares and Sucupira M.C.A. 2014. Energetic and hormonal profile of Santa Ines ewes in the middle of gestation to postpartum. *Braz. J. Vet. Res.*, 34:1251-1257.
4. Azab, M. E. and Abdel-Maksoud H. A. 1999. Changes in some haematological and biochemical parameters during prepartum and postpartum periods in female Baladi goats. *Small Ruminant Research.* 34:77-85.
5. Ballantine, H T and Herbein J H. 1991. Potentiometric determination of ionized and total calcium in blood plasma of Holstein and Jersey cows. *J. Dairy Sci.* 74:446-449.



6. Belonje, PC.1976. Normal values for ionized calcium in the plasma of normal lactating ewes and suckling lambs: relation to plasma total calcium, inorganic phosphate, magnesium and total proteins. *S. Afr. J. Anim. Sci.* 6:7-10.
7. Boudebza, A., Arzour-Lakhel N., Abdeldjelil M. C, Dib, A L, Lakhdara N, Benazzouz,H and Benlatreche C. 2016. Blood biochemical parameters in *Ouled Djellal* ewes in the periparturient period. *Der Pharma Chemica*, 8(18):406-410.
8. Brenner, K. and Seidel H.1976. Behaviour of calcium, inorganic phosphorous, magnesium and glucose concentration in the blood plasma of ewes during perinatal period. *Vet. Bulletin*, 46(11):546.
9. Caprita, R., Adrian Caprita and Iuliana Cretescu .2013. Estimation of ionized calcium and corrected total calcium concentration based on serum albumin level. *Animal Science and Biotechnologies*, 46(1).
10. Dauth, J., Dreyer M.J. and Coning de J P. 1984. Ionized calcium versus total calcium in dairy cows. *Journal of the South African Veterinary Association*. 55(2):71-72.
11. Goff, J.P., Kehrl, M.E and Horst, R. L., 1989. Periparturient hypocalcemia in cows: prevention using intramuscular parathyroid hormone. *J. Dairy Sci.* 72:1182.
12. Gurgoze, S.Y., Zonturlu, A. K., Ozyurtlu, N. and Icen, H. 2009. Investigation of some biochemical parameters and mineral substance during pregnancy and postpartum period in Awassi ewes. *Kafkas Univ. Vet. Fak. Derg.* 15(6): 957-963.
13. Iriadam, M. 2007. Variation in certain haematological and biochemical parameters during the peripartum period in Kilis does. *Small Ruminant Research* 73: 54–57.
14. Kaushik H.K. and Bugalia, NS. 1995. Total protein, cholesterol, minerals and transaminases in plasma during periparturient period in goats. *Ind. J. Ani. Sci.*, 65(7):736-743.
15. Krajnicakova, M., N.S. Kovae, M. 'Koostecky, I. Valocky, I. Maraeeek, I. Sutiakova and Lenhatdt L. 2003. Selected clinico-biochemical parameters in the puerperal period of goats. *Bull. Vet. Res. Inst. Pulawy*, 47: 177-182.
16. Kulcu, R. and Yur, F. 2003. A study of some serum mineral levels before and during pregnancy and during lactation period of sheep and cattle. *Biological Trace Element Research* Vol. 92.
17. Ozyurtlu, N. Gurgoze S.Y., Bademkiran, S., Simsek, A. and Celik, R. 2007. Investigation of some biochemical parameters and mineral levels in pre and postpartum period of Awassi ewes. *Firat Univ. J. Health Sci.*, 21(1): 33-36.
18. Riond, J. L., Kocabagli, N., Spichiger, U. E. and Wanner, M 1995. The concentration of ionized magnesium in serum during the periparturient period of non-paretic dairy cows. *Veterinary Research Communications*, 195-203.
19. Romani, A.M.P. and Scarpa, A. 2000. Regulation of cellular magnesium. *Frontiers in Bioscience*. 5:720-734.
20. Sansom, B. F., Bunch, K.J and Dew, S M. 1982. Changes in plasma calcium, magnesium, phosphorous and hydroxyproline concentration in ewes from twelve weeks before until three weeks after lambing. *Br. Vet. J.* 138:393.
21. Sava, L., Pillai, S., More U and Sontakke, A. 2005. Serum calcium measurement: total versus free (Ionized) calcium. *Indian Journal of Clinical Biochemistry*, 20(2):158-161.
22. Shappell, N. W., Herbein, J. H, Deftos, L. J. and Aiello, R. J. 1987. Effects of dietary calcium and age on parathyroid hormone, calcitonin, and serum and milk minerals in the periparturient dairy cow. *J. Nu.* 117:201.
23. Sharma, A., Kumar, P., Singh, M. and Vasishta, N. K. 2015. Haemato-biochemical and endocrine profiling of north western Himalayan Gaddi sheep during various physiological / reproductive phases. *Open Veterinary Journal*, 5(2): 103-107.
24. Shinde, A. K. and Sankhyam, S. K. 2007. Mineral profile of cattle, buffaloes, sheep and goats reared in humid southern-eastern plains of semi-arid Rajasthan. *Indian J. Small Ruminants*, 13(1): 39-44.
25. Snedecor, G. W. and Cochran, W. G. 1994. *Statistical Methods*, 8th edn .Iowa State University Press.





26. Soares, G. S. L., Souto, R. J. C., Cajueiro, J. F. P. J., Afonso, A. B. Rego, R. O., Macêdo, ATM, Soares P.C and. Mendonça, C. L. 2018. Adaptive changes in blood biochemical profile of dairy goats during the period of transition. *Revue Méd. Vét.* 169(1-3). 65-75.
27. Szenci, O., Chew, B. P, Bajcsy, A. C., Szabo, P., and Brydl E. 1994. Total and ionized calcium in parturient dairy cows and their calves. *J. Dairy Sci.* 77:1100-1105
28. Talawar, M., Veena T and Kalmath GP. 2016. Biochemical and mineral profile in NARI Suwarna ewes during late pregnancy and early postpartum period. *I.J.S.N.*, 7(4). 772-774
29. Tan, C. M., Rama A and Sinnathyray TA .1972. Serum ionic calcium levels during pregnancy. *The Journal of Obstetrics and Gynaecology of the British Common wealth.* 79:694-697.
30. Tanritanir, P., Dede S and Ceylan E. 2009. Changes in some Macromineral and biochemical parameters in female healthy siirt hair goats before and after parturition. *J Aim. Vet. Adv.* 8(3)530-533.
31. Teleb, D. F., Nashwa, A. H., Ahmed, A. Hanan, Tag El –Din, Safaa M, Abou El Soud and Omaima M H. 2014. Study on levels of Some Blood Hormonal and Biochemical Constituents during Different Reproductive Status in Saidi Ewes. *Egyptian Journal of Sheep & Goat Sciences*, 9(3):105- 113.

