ISSN:
Print - 2277 - 0755
Online - 2315 - 7453

Journal of Agricultural Science and Environment

SERUM BIOCHEMICAL CONSTITUENTS IN DOE RABBITS RE-MATED AT THREE POSTPARTUM TIME-PERIODS UNDER TROPICAL ENVIRONMENT

H.A. AWOJOBI

Department of Animal Production, Olabisi Onabanjo University,
Yewa Campus, P. M. B 0012, Ayetoro, Ogun State, Nigeria
***Corresponding author:** hezeking@gmail.com **Tel:** +2347064835049

ABSTRACT

Three groups of crossbred (New Zealand White x Chinchilla) does were used in a randomized complete block design. Does were re-mated 1-9, 10-20 and 21-28 days after parturition in the dry and rainy seasons in Ayetoro, Ogun State, Nigeria. Blood samples were collected at 2, 10 and 20 days post coitum (pc) in the does following their second parturition. The blood samples were processed and assayed for serum proteins, glucose, urea and creatinine. Serum total protein (STP) at 2 days after mating was lower ($P<0.05$) in the 1-9 days group (4.3g/dL) when compared to 10-20 days group (5.8g/dL) and 21-28 days group (5.1g/dL). Does re-mated 10 -20 and 21-28 days postpartum had a significantly ($P<0.05$) higher serum albumin than does re-mated at 1-9 days postpartum at 20 days pc. At 20 days after mating serum globulin was highest ($P<0.05$) in does re-mated 1-9 days post partum. Serum glucose at 2 and 20 days after mating were not significantly ($P>0.05$) affected by postpartum re-mating interval. At 20 days after mating however, serum urea and creatinine decreased ($P<0.05$) as postpartum re-mating interval increased. Serum total protein, serum albumin, glucose and urea were significantly ($P<0.05$) higher in the dry season than rainy season. However, most values obtained fall within normal ranges for the domestic rabbit except serum globulin. The result of this research has demonstrated little or no stress to internal physiology due to concurrent pregnancy and lactation at least in the short run.

Keywords: Doe-rabbit, re-mating interval, serum profile, tropics

INTRODUCTION

The rabbit has a high fecundity rate. Ovulation is normally induced by the stimuli associated with coitus and occurs 9 to 10 hours after mating (Ramirez and Soufi, 1993). The rabbit have a gestation length of 29 to 33 days (MAFF, 1973). Cheeke (1986) reported that rabbit does will breed within 24 hours of parturition. Thus, it is theoretically possible to produce over 11 litters per doe per year. Based on postpartum re-mating interval, three basic systems of reproduction are recognized in rabbit reproduction; extensive, semi-intensive and intensive. According to Cervera *et al.* (1993), farmers usually plan a re-mating interval of 1 to 2days post parturition (intensive production), 7-14 days (semi-intensive) or 14 days onward (extensive). However, according to Lebas *et al*. (1997) extensive reproduction rate utilizes the doe's maternal instinct by allowing them to nurse their young for five to six weeks, rebreeding soon after weaning. This definition really describes the practice in most developing

nations, including Nigeria. According to Lebas *et al.* (1997), in semi-intensive reproduction the does are serviced 10-20days after kindling while in the intensive, does are serviced the same day or the day after kindling (the true postpartum rate), or 3-4 days after kindling or *ad lib* for 48hours following kindling. Productive and reproductive response of the domestic rabbit to the different rates of reproduction under tropical and subtropical environment in Nigeria has been reported (Iyeghe-Erakpotobor *et al.*, 2005; Awojobi and Adejumo, 2009; Awojobi *et al.*, 2011). However, little or no information is available on the serum biochemistry of does subjected to different rates of reproduction.

The introduction of cycled production and artificial insemination has improved management and productivity of the doe. However, cyclic production is giving way to the development of different reproduction protocols since continuous postpartum rhythm decreases fertility rate and length of reproductive activity (Parigi-Bini *et al*., 1989) and only a few does can sustain a fixed postpartum rhythm (Castellini *et al*., 2003).

In the tropics there is dearth of information on the physiology of the domestic rabbit after parturition. A proper understanding of postpartum physiology in the domestic rabbit under the tropical environment will assist in establishing the most effective ways of managing rabbit reproduction for optimal performance. It will also enable an avenue for mapping out strategy for improving reproductive performance.

This study was carried out to elucidate the response of doe rabbits to different postpartum re-mating time period using some serum biochemical constituents as a basis for establishing reproduction protocols for optimal production performance of the doe rabbit.

MATERIALS AND METHODS

Location of Study

The experiment and laboratory investigations were carried out at the rabbitary of the Teaching and Research Farm and Animal Nutrition and Physiology Laboratory respectively of the Olabisi Onabanjo University, Yewa Campus, Ayetoro. Ayetoro is located on latitude 7^{O} 15'N and longitude 3^{O} 3'E in a deciduous/derived savannah zone of Ogun State. Climate is sub-humid tropical with an annual rainfall of 1,909.3mm. Rainy season is between early April and late October. Rainfall pattern is bimodial with two peaks in June and September. Maximum temperature varies between 29^{O}C during the peak of the wet season and 34^{O}C at the onset of the wet season. Mean annual relative humidity is 81% (Onakomaiya *et al.,* 1992).

Animals and their Management

A total of one hundred and eight (108) New Zealand White × Chinchilla does Cross were used for this experiment. The does (54 each in the dry and rainy season) were allocated to three experimental post partum re-mating time-periods: Intensive (IN; 1-9 days), Semi-intensive (SI; 10-20 days), Extensive (EX; 21-28 days) postpartum. These does were in their second parturitions along these experimental groupings at the time of experimentation. Feeding and watering were *ad libitum.* Does were fed a concentrate ration (Table 1) only. Does were individually housed in flat-decked wooden hutches measuring 90 × 60× 45cm. Does were subjected to natural lighting and ventilation throughout the experiment.

Table 1: Composition of the experimental diet

Ingredient	Quantity (%)
Maize	32.40
Soya bean meal	23.10
Wheat meal	9.30
Palm kernel cake	13.90
Brewers dried grain	13.90
Fish meal (72%)	1.86
Palm oil	1.80
Oyster shall	1.40
Bone meal	1.85
Premix	0.20
Salt	0.30
Analysis	
Dry matter (%)	91.50
Energy (Kcal ME/Kg)	2666.88
Crude protein (%)	23.80
Ether extract (%)	6.45
Crude fibre (%)	10.84

Premix supplied the following per Kg of feed: Vit A, 10,100.00 i.u; Vit D_3, 2000.00 i.u Vit E 30mg; Vit K_3, 2mg ; Vit B_1, 100mg; Vit B_2, 400mg; Nicotinic acid, 25.00mg; Panthothenic acid, 8.00mg; Vit $_{B6}$, 3.00mg; Vit B_{12}, 0.015mg; Folic acid, 0.80mg; Biotin, 0.030mg; Choline Chloride, 200.00mg;Manganese,100.00mg, Iron, 50.00mg Zinc, 45.00mg; Copper, 2.00mg; Iodine 1.55mg; Cobalt, 0.25mg; Selenium, 0.10mg; Ethoxyquin, 100.00mg.

Data Collection

Blood sample was collected from the does at 2 days, 10 days and 20 days after mating. 5 mls of blood was collected from the jugular vein of the rabbits using needle and syringe. The blood was discharged into sterilized test tubes (without anticoagulants), allowed to clot and centrifuged at 500 revolutions per minute for 20minutes. The serum was decanted into sterile sample bottles and kept in the freezer until ready for the analysis of serum metabolites.

The serum metabolites of interest were serum total proteins, serum albumin, serum urea, serum creatinine and serum glucose. The serum globulin was determined as the difference between serum total protein and serum albumin and the albumin and globulin ratio was subsequently calculated.

Serum total protein was estimated using the Biuret method (Jain, 1986). The bromocresol purple method of Varley *et al*. (1980) was used for the determination of serum albumin. Urea estimation was done using diacetyl monoxime as described by Jain (1986). Serum creatinine determination was carried out as described by Kaplan and Szabo (1983) and glucose estimation was done using the glucose oxidase method (Jain, 1986).

Data Analysis

All data were analysed using the GLM procedure of SAS (1999) for a randomized complete block design, with re-mating interval and season as factors of variation employing the model:

Yijk = m +Mi + Sj + Eijk, where

Yij = Individual observation
m = General population mean
Mi = Effect of mating system i
Sj = Effect of season j.
Eijk = Composite error effect

Significant means were separated using the Duncan's multiple range test of the same statistical software.

RESULTS

Serum total protein (STP) was significantly ($P<0.05$) lowest in does under intensive mating system at day 2 of gestation (Table 2). At day 10 after mating, STP decreased as postpartum re-mating interval increased, whereas at day 20 of gestation, STP increased as postpartum re-mating interval increased. The days 10 and 20 of gestation, serum total protein values were however not significantly ($P>0.05$) influenced by postpartum re-mating interval. Within group, does under the semi-intensive and extensive mating systems have an increase in STP as the number of days after mating increased. For does under intensive mating system there was increase from day 2 to 10 followed by a slight decrease at day 20 post mating. Serum total protein was significantly ($P<0.05$) higher in the dry season than rainy season at days 2 and 10 post coitum. Values were however not significantly ($P>0.05$) different between the two seasons at day 20 after mating.

Table 2: Effects of experimental postpartum re-mating interval and season on serum total protein of doe rabbits

Parameters	Gestation Age	Re-mating Interval			SEM	SEASON		SEM
		Intensive	Semi – Intensive	Extensive				
		1-9 days	10-20days	21-28 days		Dry	Rain	
Total Protein(g/dl)	2	4.34[b]	5.76[a]	5.09[a]	0.27	5.46[a]	4.38[b]	0.04
Total Protein(g/dl)	10	6.51	5.99	5.42	0.35	6.46[a]	5.20[b]	0.29
Total Protein(g/dl)	20	6.12	6.34	6.43	0.42	6.25	6.34	0.40

[ab] Means on the same row with different superscripts are significantly different ($P < 0.05$).
SEM: Standard error of means

Table 3 shows the effect of postpartum re-mating interval and season on serum albumin in doe rabbits. Serum albumin was significantly (P<0.05) higher in doe rabbits in semi-intensive mating system than intensive and extensive mating systems at 2 day post-mating. At 10 days after mating, there was no significant (P>0.05) difference among all three mating systems. Albumin content increased with increased postpartum re-mating interval at 20 days after mating. Does under the semi-intensive and extensive mating systems had a significantly (P<0.05) higher serum albumin than does under the intensive mating system at 20 days post-mating. Serum albumin was significantly (P<0.05) higher in the dry season at 2 and 10 days after mating, while it did not show any significant (P>0.05) seasonal variation at 20 days after mating. Serum albumin followed the same trend as total serum protein, increasing with increasing post coitum days in does under semi-intensive and extensive mating systems, while it increased from 2 to 10 days post coitum and decreased at 20 days post coitum in does under intensive mating system.

Table 3: Effects of experimental postpartum re-mating interval and season on serum album of doe rabbits

Parameters	Gestation Age	Re-mating Interval			SEM	SEASON		SEM
		Intensive	Semi – Intensive	Extensive				
		1-9 days	10-20 days	21-28 days		Dry	Rain	
Albumin (g/dl)	2	3.08[b]	4.01[a]	2.50[b]	0.16	4.19[a]	2.70[b]	0.11
Albumin (g/dl)	10	4.19	4.23	3.75	0.20	4.40[a]	3.52[b]	0.16
Albumin (g/dl)	20	3.49[b]	4.66[a]	4.70[a]	0.57	4.24	4.32	0.51

[ab] Means on the same row with different superscripts are significantly different (P < 0.05).
SEM: Standard error of means

Serum globulin was not significantly (P>0.05) influenced by postpartum re-mating interval at 2 and 10days after mating (Table 4). At 20 days after mating serum globulin was significantly (P<0.05) higher in does under the intensive mating system than does under the semi-intensive and extensive mating systems. Within group, does under intensive and extensive mating systems have increasing level of serum globulin with increase in gestational age. In does under semi-intensive mating system, serum globulin increased from 2 to 10 days after mating with a subsequent decrease at 20 days after mating.

Table 5 shows the albumin/globulin ratio as influenced by postpartum re-mating interval and season. Albumin/globulin ratio at 20 days after mating was comparable (P>0.05) in does under the semi-intensive and extensive mating systems and their values was

significantly (P<0.05) higher than that of does under intensive mating system. Albumin/globulin ratio was not significantly (P>0.05) affected by postpartum re-mating interval at 2 and 10 days after mating. Albumin/globulin ratio was significantly (P<0.05) higher in the dry season than rainy season at 2 days after mating. Values were however not significantly (P>0.05) influenced by seasonal changes at days 10 and 20 post coitum.

Table 4: Effects of postpartum re-mating interval and season on serum globulin in doe rabbits

Parameters	Gestation Age	Re-mating Interval: Intensive	Semi – Intensive	Extensive	SEM	SEASON		SEM
		1-9 days	10-20days	21-28 days		Dry	Rain	
Globulin (g/dl)	2	1.25	1.75	1.58	0.18	1.27[b]	1.68[a]	0.13
Globulin (g/dl)	10	2.21	1.76	1.68	0.25	2.00	1.69	0.20
Globulin (g/dl)	20	2.75[a]	1.68[b]	1.73[b]	0.50	1.97	2.12	0.47

[ab] Means on the same row with different superscripts are significantly different (P < 0.05). SEM: Standard error of means

Table 5: Effects of postpartum re-mating interval and season on serum albumin/ globulin ratio of doe rabbits

Parameters	Gestation Age	Re-mating Interval: Intensive	Semi – Intensive	Extensive	SEM	SEASON		SEM
		1-9 days	10-20days	21-28 days		Dry	Rain	
Albumin/ globulin ratio	2	2.99	2.77	2.57	0.56	3.71[a]	1.93[b]	0.40
Albumin/ globulin ratio	10	1.91	3.21	2.35	0.63	2.80	2.02	0.52
Albumin/ globulin ratio	20	1.34[b]	2.80[a]	2.79[a]	0.63	2.44	2.23	0.45

[ab] Means on the same row with different superscripts are significantly different (P < 0.05).
SEM: Standard error of means

The effects of experimental postpartum re-mating interval and season on serum glucose level are presented in Table 6. Serum glucose level was significantly (P<0.05) higher in does under semi-intensive mating system when compared with those under intensive and extensive mating systems at 10 days after mating. Serum glucose at 2 and 20 days after mating were not significantly (P>0.05) affected by postpartum re-mating interval. Serum glucose was significantly (P<0.05) higher during the dry season at 2, 10 and 20 days after mating.

Table 6: Effects of experimental postpartum re-mating interval and season on serum glucose level in doe rabbits

Parameters	Gestation Age	Re-mating Interval			SEM	SEASON		SEM
		Intensive	Semi – Intensive	Extensive				
		1-9 days	10-20days	21-28 days		Dry	Rain	
Glucose (mg/dl)	2	113.56	120.93	115.54	10.57	161.46[a]	70.70[b]	7.48
Glucose (mg/dl)	10	104.50[b]	128.89[a]	101.86[b]	6.51	138.69[a]	71.74[b]	5.36
Glucose (mg/dl)	20	93.28	95.96	97.20	5.38	107.33[a]	86.14[b]	4.85

[ab] Means on the same row with different superscripts are significantly different (P < 0.05). SEM: Standard error of means

Table 7: Effects of experimental postpartum re-mating interval and season on serum urea level of doe rabbits

Parameters	Gestation Age	Re-mating Interval			SEM	SEASON		SEM
		Intensive	Semi – Intensive	Extensive				
		1-9 days	10-20days	21-28 days		Dry	Rain	
Urea (mg/dl)	2	34.31	37.01	31.51	2.67	47.56[a]	21.49[b]	1.89
Urea (mg/dl)	10	29.28[b]	32.59[b]	40.54[a]	2.02	44.48[a]	19.90[b]	1.67
Urea (mg/dl)	20	28.09[a]	24.05[b]	21.05[b]	1.95	31.85[a]	18.32[b]	1.25

[ab] Means on the same row with different superscripts are significantly different (P < 0.05). SEM: Standard error of means

Values were however lowest in does under extensive mating system and highest in does under semi-intensive mating system. At 10 days after mating serum urea increased as postpartum re-mating interval increased, and values were significantly (P<0.05) higher in does under extensive mating system than intensive and semi-intensive mating systems. At 20 days after mating however, serum urea decreased as postpartum re-mating interval increased and does under intensive mating system had a higher (P<0.05) value than those under semi-intensive and extensive mating systems. At 2, 10 and 20 days after mating serum urea was significantly (P<0.05) higher in the dry season than rainy season.

Table 8: Effects of experimental postpartum re-mating interval and season on serum creatinine level of doe rabbits

Parameters	Gestation Age	Re-mating Interval			SEM	SEASON		SEM
		Intensive	Semi – Intensive	Extensive				
		1-9 days	10-20days	21-28 days		Dry	Rain	
Creatinine (mg/dl)	2	1.67	1.82	1.78	0.18	1.93	1.55	0.13
Creatinine (mg/dl)	10	1.41[b]	2.32[a]	1.60[b]	0.13	1.85	1.65	0.11
Creatinine (mg/d)	20	1.90[a]	1.60[b]	1.32[c]	0.11	1.67	1.56	0.08

[ab] Means on the same row with different superscripts are significantly different (P < 0.05). SEM: Standard error of means

At 2 days after mating serum creatinine was not significantly (P>0.05) influenced by postpartum re-mating interval (Table 8). The trend of serum creatinine at 10 days followed the same pattern as that of 2 days increasing from intensive to semi-intensive and decreasing slightly at extensive mating system. However at 10 days after mating, does under semi-intensive mating system showed a significantly (P<0.05) higher serum creatinine level than does under intensive and extensive mating systems. At 20 days after mating serum creatinine decreased as postpartum re-mating interval increased and values were significantly (P<0.05) different from one another. At 2, 10 and 20 days post coitum serum creatinine did not show any significant (P>0.05) seasonal variation.

DISCUSSION

The total protein values of 4.34, 5.76 and 5.09 g/dl observed at 2 days of gestation in does under intensive, semi-intensive and extensive re-mating is lower than the normal range of 6.00 – 8.30 g/dl literature value reported by Mitruka and Rawnsley (1977) and Kozma *et al*. (1974). Though Awojobi *et al*. (2004) has reported a significant effect of physiological status on serum total protein, the lower value in does under intensive re-mating cannot be attributed to concurrent pregnancy and lactation. In any case, as at 2 days after mating, all the groups were still lactating though at different stages. There-

fore, the observation on the does under intensive re-mating will probably be due to the closeness of re-mating to the last parturition. The rabbits had probably not recovered from total serum protein depletion arising from blood loss during parturition. This is buttressed by the results at 10 days of gestation in which does under intensive re-mating did not only have the highest value but also is the only group where the mean value observed falls within the normal range. By the end of the second trimester, values had fallen within the normal range in all the three groups. From the results of the earlier experiments, lower values of total protein in does re-mated intensively did not have deleterious effect on ovulation and fertilization (Awojobi and Adejumo, 2009). Serum albumin recorded throughout the experiment falls within the normal range of 2.42 – 4.05 g/dl in literature. The low values of serum albumin in does under extensive re-mating at 2 days Post coitum. is a reflection of the depletion of body reserve from nursing. Again, concurrent pregnancy and lactation could not have been said to affect serum albumin negatively at 2 and 10 days post coitum, while the results at 20 days gestational age. suggest a possible influence of concurrent pregnancy and lactation. The values were still within the normal range. The seasonal variation in serum total protein and albumin is not quite understandable. The significant difference in globulin at 20 days post coitum may be attributable to concurrent pregnancy and lactation. Awojobi *et al*. (2004) had reported comparable globulin values in pregnancy and lactation, which was higher than that of non-pregnant, does. It is reasonable to imagine that when pregnancy coexists with lactation, the values might be higher. The difference in globulin at 2 days post coitum. between the dry and rainy seasons may also not be unconnected with the probability of higher incidence of pathogens in the rainy season . Based on the literature values of 0.68 – 1.15 for albumin/globulin ratio (Mitruska and Rawnsley, 1977), values in this experiment were higher than normal values across all mating systems. This obviously has to do with lower than normal levels of globulin. In fact it is the does rebred intensively that seemed to come near the normal range at 20 days of gestation. Serum glucose results also fell within the normal range of 78 – 155 mg/dl for the domestic rabbit. Any differences observed in this research were of no detrimental effect to the animal.

Serum urea values though not significantly influenced by experimental grouping were higher than literature values of 13.1 – 29.5 mg/dl (Mitruska and Rawnsley, 1977) for the domestic rabbit, although normal values as high as 35 mg/dl has been reported for the Dutch belted rabbit (Kozma *et al*., 1974) By 10 days post coitum, values had approached normal range for does under intensive re-mating. At 20 days of gestation all values were within the normal range. The mean values for urea are however not very consistent with the observations for proteins. Creatinine values were within normal range of 0.5 – 2.65 mg/dl reported for the domestic rabbit by Mitruka and Rawnsley (1977). Significant differences even if attributable to concurrent pregnancy and lactation are not really of any practical significance.

CONCLUSION

There was a lower serum total protein at 2 days post coitum in does under intensive re-mating, which was certainly not due to physiological status, while the lower albumin value for does under extensive re-mating at the same period was probably due to the stress of nursing. The lower serum albumin

value at 20 days post coitum in does under intensive re-mating is probably due to the stress of concurrent pregnancy and lactation, nevertheless the values observed were still within the normal range for the domestic rabbit. Other variations in serum biochemical values are within narrow limits and most fell within the normal range for the domestic rabbit. The result of this research has demonstrated little or no stress to internal physiology due to concurrent pregnancy and lactation at least in the short run. Any reproduction protocol that involves concurrent pregnancy and lactation can be safely practiced at least in the short run. Future studies should however examine such protocols in the long run. Serum mineral profile, triglycerides, hormonal profile and use of anti-stress can be incorporated into future investigations.

REFERENCES

Awojobi, H.A., Opiah, G.O., Sotuminu, G. 2004. The effect of physiological status on nutrient digestibility and some blood parameters of the New Zealand White doe rabbit. *Journal of Agric, Forestry and the Social Sciences,* 2(2): 95-103.

Awojobi, H.A., Adejumo, D.O. 2009. Reproduction study in doe rabbits re-bred at three postpartum re-mating time-periods in a tropical environment. *World J. Zool.,* 4(1): 14-18.

Awojobi, H.A., Awojobi, E.A., Adejumo, D.O., Eniolorunda, O.O., Aluko, F.A. 2011. The effects of reducing postpartum re -mating time-period on reproductive performance of the doe rabbit. *Archivos de Zootecnia,* 60(231): 501-512.

Castellini, B., DalBosco, A., Muguai, C. 2003. Comparison of different reproduction protocols for rabbit does: effect of litter size and mating interval. *Livestock Production Science,* 60(2-3): 229-241.

Cervera, C.J., Fernadez-Carmona, J., Viudes, P., Blas E. 1993. Effect of re-mating interval and diet on the performance of female rabbits and their litters. *Anim. Prod.*, 56: 399-405.

Cheeke, P.R. 1986. Potential of rabbit production in tropical and sub-tropical Agricultural System. *J. Anim. Sci.,* 63: 1581-1586.

Iyeghe-Erakpotobor, G.T., Oyedipe, E. O., Eduvie, L.O., Ogwu, D. 2005. Effect of rebreeding interval on reproductive performance and body weight changes of does during pregnancy. *Nig J. Anim. Prod.,* 32(1): 142-152.

Jain, N.C. 1986. *Schalms Veterinary haematology 4th ed.* Lea and Febiger, Philadelphia.

Kaplan, A., Szabo, L.L. 1983. *Clinical Chemistry: Interpretation and Techniques.* 2nd ed. Lea and Febiger.

Kozma, C. Macklin, W., Cummins, L., Mauer, R. 1974. *Anatomy, Physiology and Biochemistry of the rabbit. : The Biology of the laboratory rabbit.* Weisbroth, S. H., Hatt R. E. and Krims A. C. Eds. Academic Press, New York. 49-71.

Lebas, F., Coudert, P., Rouvier, R., De Rochambeau, H. 1997. *The rabbit-husbandry, health and production (new revised version).* 3rd ed. FAO, Rome.

MAFF. 1973. *Commercial Rabbit Production. Bulletin 50.* Ministry of Agriculture, Fisheries and Food, London.

Mitruka, B.M., Rawnsley, H.M. 1977. *Clinical Biochemical and Haematological Reference Values in Normal Experimental Animals.* 1st ed. Masson Publishing U.S.A.

Onakomaiya, S.O., Oyesiku, K.A., Jegede, S.J. 1992. *Ogun State in Maps.* 1st ed. Rex Charles Publications, Ibadan.

Parigi-Bini, R., Xiccato, G., Gnetto, M. 1989. Influenza dell'intervallo parto-acco ppiamento sulle prestazioni reproduttive delle coniglie fattrici. *Riv. di Coniglicoltura,* 26: 51-57.

Ramirez, V.D., Soufi, W.L. 1993. The neu-roendocrine control of the rabbit ovarian cycle. *The physiology of reproduction.* E. Knobil and J. D. Neill, Eds. Raven Press: New York. 585-611.

SAS Institute 1999. *SAS/STAT Users guide, version 6. 11.* 5th ed. Vol. 2 Statistical Analysis System Institute Inc. Cary N. C.

Varley, H., Gowelock, A.H., Bell, M. 1980. *Determination of serum urea using the acetyl monoxide method. Practical Biochemistry.* 5th ed. William Heinemann Medical Books Ltd., London.

(Manuscript received: 17th June, 2011; accepted: 21st September, 2012).