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RESEARCH ARTICLE

Serum Macrominerals, Glucose and Triglycerides in Arabian Mares during Different Phases of Reproduction Cycle

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ABSTRACT

The aim of this study was to determine the difference in biochemical serum constituents of Arabian mares during different phases of the reproduction cycle. According to there reproductive status, mares were assigned to one of the following six groups, i.e., filly (n=5), late pregnancy (n=7), early pregnancy (n=11), estrual mares (n=8), infertile mares (n=8) and mares in post partum less than 8 days (n=4). Serum calcium, phosphorus, sodium, potassium, magnesium, glucose and triglycerides were determined. Calcium and phosphorus levels were significantly ($P<0.05$) higher in infertile and filly group, respectively. Sodium level was significantly lower in infertile than in all other groups and the higher serum level was observed in early pregnant mares. Concerning potassium, mean levels were significantly higher than in filly and the lowest mean values were observed in post foaling mares, however, no significant difference was observed in magnesium levels between all groups. Glucose concentration in early pregnant mares was lower than all other groups, but the difference was significant with mares in estrus and fillies. Triglycerides were significantly ($P<0.05$) higher in late pregnancy and infertile mares than in filly, in early pregnancy, in estrus and in post foaling mare groups. In this study, results pointed towards the significant influence of reproductive statuses on some biochemical serum constituents in mares.

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INTRODUCTION

Since 1886, Arabian horses were bred in Algeria in the national Haras of Chawchawa. Animals were used only for hippisme and reproduction. Fertility was always controlled by a qualified personnel or the veterinarian; lately, the ultrasonography was introduced for a best control of reproduction. Regarding to the origin of the studied breed, Arabian horses are considered as hot-blooded species, characterized by their higher metabolic requirements (Kaneko, 1997).

Requirement of calcium, phosphorus, and magnesium during pregnancy tend to increase as compared to growing fetus period (Huntington *et al*., 2005; Begum *et al*., 2010). Ali *et al*. (2004) revealed higher calcium levels in estrus mares when compared with infertile mares. Some studies have also linked the deficiency of various minerals with specific reproductive disorders. Magnesium deficiency delays the uterine involution (Larvor, 1983), and causes fetal loss and irregular estrus cycle in mares. Mineral and vitamins deficiency causes embryonic death and anoestrus leading to infertility (Sane *et al*., 1994). According to Church and Pond (1974), based on available data in animal nutrition, it can be inferred that macro minerals metabolism and nutrition, with some exceptions, is similar among animal species and therefore observations on one species may be extrapolated to others. Sane *et al*. (1994) reported hormonal dysfunction, genetic disabilities, and the management factors including the nutrition of brood mares to be the major causes of infertility in mares, however no deficiency of magnesium and potassium in the mares at any management condition was revealed (Ali *et al.,* 2010).

Inadequate nutrition can be detrimental to the reproduction of livestock (Schillo, 1992). The body condition of mares at the time of breeding can influence the rate of conception (Henneke *et al*., 1984).

Information about the relationship between the levels of biochemical serum constituents and fertility in equines in published literature is scanty. While attempting to

delineate the causes of infertility in mares, it was felt that the study of biochemical constituents of mare serum might be very helpful. We are so certain that no similar work have been yet done in Algeria. The present study was conducted to find a direct correlation between fertile Arabian mares with the biochemical profile and serum concentration of various macro minerals (calcium, inorganic phosphorus, magnesium, sodium, and potassium), glucose and triglycerides.

MATERIALS AND METHODS

The present study was conducted on 43 pure bred mares aged between 2 to 23 years, during 2009-2010 in Tiaret, Algeria. All animals belong to the national Haras of Chawchawa. The history of these animals since birth was recorded. The animals were fed barley, fodder and seasonal water *ad libitum*.

The mares were grouped according to their reproductive status. The reproductive statute of each mare was determined according to its recorded history, in conjunction with results obtained with rectal examination and the ultrasonography. Mares were assigned to six groups. Group 1 (n=5) comprised of filly of two years of age. Group 2 (n = 7) consisted of mares being in late pregnancy, as reported in the Register of mating of the previous year. The Group 3 (n=11) contained mares diagnosed pregnant by ultrasonography for more than 60 days and less than 80 days. Group 4 (n= 8) included the mares that were found to be in estrus at the time of sample collection; the estrus status was confirmed by visual signs and by the presence of a dominant follicle on the ovary by ultrasound. Group 5 (n= 8) comprised of mares with reproductive troubles, without any foaling during the last 24 months. The mare lying in the first six days after foaling have formed the group 6 (n = 4).

Jugular blood samples were collected directly in a clean sterile test tube from each mare early in the morning before feeding. The blood samples were brought to the biochemical laboratory within two hours for analysis. Serum was immediately separated by centrifugation. Serum levels of magnesium, phosphorus, calcium, glucose and triglycerides were determined using a Roche® COBAS *Integra 400* plus analyzer (France). Sodium and potassium plasma levels were determined by plasmatic selective electrodes "*Medica Easylyte* ILyte *Electrolyte* Analyzer (UK)".

For the studied parameters, data were arranged in 6 x 7 categories. For each category, mean and standard deviation values were determined. Data of various categories were analyzed statistically using one-way ANOVA and means compared then by DMR at the significance level of $P<0.05$.

RESULTS AND DISCUSSION

Calcium

Calcium and inorganic phosphorus represent 70% of the organism's total content of minerals (Harrison, 1998); its biological function is well known, nevertheless in horses, its homeostatic regulation is not yet clear (Breidenbach *et al*., 1998). The negative effect of calcium and phosphorus deficiency on reproduction in cattle has been reported (Hurley and Doem, 1989). In the present study, calcium levels in infertile group was significantly ($P<0.05$) higher than all other groups (Table 1). Martin *et al.* (1996) reported no significant difference in calcium levels between different age and reproductive stages however Ali *et al.* (2004) reported values significantly higher in estrual mares than in pregnant, infertile and regular breeders. Lumsden *et al.* (1980) reported 2.89 and 3.09 mmol/L of serum calcium values in thoroughbred mares. Frape (1986) reported mean values of calcium in horse to be 3.2 mmol/L. Cymbaluk and Christison (1989) and Martin *et al.* (1996) reported serum calcium levels from 2.75 to 2.77 mmol/L in non pregnant mares.

In this study, infertile mares had significantly higher calcium levels (3.78±0.51 mmol/L) which can be explained by a lesser calcium use by the body in absence of milk production in difference with post foaling mares having a lower value (2.74±0.09 mmol/L).

Inorganic phosphorus

Our results reported that the filly group had phosphorus level significantly higher than all other groups ($P<0.05$). However, these values were in the average of values reported by Frap (1986), between 0.5 and 1.6 mmol/L. Lumsden *et al.* (1980) reported that phosphorus serum values for thoroughbred mares were between 0.36 and 1.42 mmol/L. Our recorded values were lower than 2.03 mmol/L, values reported by Cymbaluk and Christison (1989). In our results, the calcium to phosphorus ratio was significantly ($P<0.05$) lower in filly than in infertile group (2.17±0.41 vs 4.42±1.61) and in post foaling mares group (2.17±0.41 vs 3.42±0.30). However, except for fillies, the value of this ratio in the other groups of mares was in the average of the value reported by Lumsden *et al*. (1980).

Magnesium

In this study no significant difference was observed in the serum level of magnesium, however, all values were lower than those reported by Lumsden *et al.* (1980) for non pregnant, in early pregnancy and in late pregnancy groups of mares. According to Hurley (1971), a low serum magnesium level can cause either complete sterility or considerable fetal malformation with resumption and abortion.

Sodium

Sodium level, in this study, was significantly lower ($P<0.05$) in infertile than in all other groups and the higher serum level was observed in early pregnant mares. Sodium makes the principal base of plasma and its function appears to be physiochemical in nature, where it is responsible to maintain osmotic pressure and acid base balance. A decrease in serum sodium contents in physiological conditions like pregnancy or pathological conditions like pneumonia has been seen (Cornelius and Kaneko, 1963). Our findings in this study are in concordance with values reported by Ali *et al.* (2010) and approaching values reported by Lumsden *et al.* (1980) for non pregnant, early pregnant and late pregnant mares.

Table 1: Serum levels of macrominerals, glucose and triglycerides, in filly, late pregnant, early pregnant, oestrus infertile and post foaling mares

Reproductive status	n	Calcium (mmol/L)	Inorganic Phosphorus (mmol/L)	Magnesium (mmol/L)	Sodium (mmol/L)	Potassium (mmol/L)	Glucose (mmol/L)	Tri-Glycerides (g/L)
Filly	5	2.91±0.03^{a}	1.32±0.25^{b}	0.57±0.07	135.62±1.75^{ac}	4.39±0.64^{a}	7.36±0.56^{a}	0.17±0.06^{ac}
Late pregnant	7	3.13±0.62^{a}	0.91±0.11^{a}	0.67±0.05	133.29±4.24^{a}	4.03±0.29^{abc}	7.09±0.51^{ab}	0.29±0.07^{b}
Early pregnant	11	2.81±0.16^{a}	0.93±0.13^{a}	0.61±0.09	137.21±1.16^{c}	3.56±0.54^{bc}	6.55±0.50^{b}	0.12±0.03^{a}
Oestrus	8	2.71±0.21^{a}	0.97±0.21^{a}	0.67±0.09	136.46±2.60^{ac}	3.63±0.85^{bc}	7.25±0.59^{a}	0.18±0.04^{ac}
Infertile	8	3.78±0.51^{b}	0.93±0.22^{a}	0.62±0.04	129.67±2.59^{d}	3.98±0.32^{abc}	7.17±0.41^{ab}	0.24±0.13^{bc}
Post foaling	4	2.74±0.09^{a}	0.81±0.08^{a}	0.59±0.04	135.83±2.90^{ac}	3.16±0.24^{c}	7.15±0.20^{ab}	0.13±0.02^{ac}

Values (Mean±SD) with different superscripts in a column differ significantly (P<0.05).

Snow *et al.* (1982) have reported average serum sodium level of 132.76 mmol/L, whereas Errington (1937) reported a serum sodium level of about 161.8 mmol/L. Values determined for most of our groups are within the previously reported ranges, but the mean values recorded in infertile group was lower.

Potassium

In our results, the mean levels of potassium was significantly higher than in filly (P<0.05), however, the lowest mean values was observed in post foaling mares (P<0.05).

Lumsden *et al.* (1980) reported values for thoroughbred mares to be 3.5±0.5 mmol/L. Naheed (2004), however, has reported different serum potassium levels in pregnant, fertile and sub fertile mares (5.19, 2.99 and 4.31 mmol/L respectively), which are in concordance with our findings. Lumsden *et al.* (1980) has reported sodium to potassium ratio for thoroughbred mares to be 40.4±7.3. In this study, post foaling mares had a sodium to potassium ratio of 43.15±3.60, higher than all other groups, but only significant (P<0.05) for late pregnancy and infertile groups.

Glucose

Serum glucose values in early pregnant mares were lower than all other groups, but the difference was significant (P<0.05) with mares in estrus (7.25±0.59 mmol/L) and fillies (7.36±0.56 mmol/L). Lumsden *et al.* (1980) observed the influence of the stage of pregnancy on many blood parameters; the latter found that glucose is significantly higher (P<0.05) in late pregnant mares, and for non pregnant, early pregnant and late pregnant mares, the values were 5.44, 5.33 and 6.60 mmol/L, respectively, which is in concordance with our findings. The early pregnancy in mares coincides with beginning of milk yielding which can explain a lower level of serum glucose. Moreover, Fowden *et al. (*2002) reported that there was a significant uptake of glucose by the gravid uterus, fetus and uteroplacental tissues at both mid and late gestation. The feed and stage trend is likely to represent an overall decrease in glucose removal from blood later in lactation, when the rate of glucose removal from blood specifically for milk lactose synthesis and volume production is decreased. (Evans, 1971)

Triglycerides

The fatty acids metabolism from the aspect of energy imbalance in horses, especially at the outset of the last trimester of pregnancy and up to 8-10 weeks of lactation period, is not fully elucidated. This period is characterized with a marked foetus growth, mare preparation for delivery, beginning of lactation, and nursing of the newborn foal. At that time, apart from mare living demands, there are recorded increased requirements for energy, protein, and minerals, conditioned by the fast growing fetus (Mochol *et al.,* 2009).

In this study, the mean values of serum triglycerides was significantly higher in late pregnancy and infertile mares (P<0.05), than in filly, in early pregnancy, in estrus and in post foaling mare groups. Mochol *et al.* (2009) reported triglycerides serum average values to be of 0.86±0.40 mmol/L in late prenatal mares, and of 0.35±0.13 mmol/L in late pregnancy mares. These values are in concordance with those recorded in our study.

Conclusions

Differences in macrominerals, glucose and triglycerides serum levels between mares in different stages of reproductive cycle could be explained by specific requirements of each status. The mare is able to adapt to different food situations in which it faces, but the extreme excesses or deficiencies in the various biochemical constituents can cause a significant reduction in reproductive performance. The experimental study of the influence of various nutritional deficiencies on metabolic profile and their impact on the reproductive performance of Arabian mares is necessary for better understanding of these mechanisms.

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