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Factors Affecting Serum Trace Elements of Breeding Ewes in Central Saudi Arabia

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ABSTRACT

Background: Trace elements are indispensible for animal production and reproduction. Their requirements rely on many factors. Some of these factors have been studied in earlier reports but still other factors under investigation. The aim of the present study was to investigate factors affecting the level of manganese (Mn), selenium (Se), iron (Fe) and zinc (Zn) of sheep in Qassim Region, Central Saudi Arabia.

Methods: Total of 131 clinically healthy and non-pregnant ewes were assigned for this study. Ewes were classified according to breed, parity, body condition score, housing system and feeding type. The animals were bled immediately after examination and sera were analyzed for trace elements using spectrometry.

Result: Results showed that Awassi breed had higher Se, Fe and Zn levels than other breeds. Parity affected Se and Fe levels. Age, body condition score and parity affected Zn concentration. It can be concluded that breed, parity, age, body condition score, housing and feeding type could affect the level of serum trace elements in breeding ewes in central Saudi Arabia.

Key words: Breed, Feeding, Parity, Sheep, Trace elements.

INTRODUCTION

The nutritional requirements of minerals and trace elements and their role in animal health and production are still an interesting area of research which acquired a wide range of debate among the nutritionist interested in human and animal welfare. Trace elements may function as activators of enzymes, as cofactors, or stabilizers of supplementary molecular construction (Nawito *et al*., 2015). Though, these elements are mostly required in small quantities but are quiet vital for optimum health and production (Ali *et al*, 2021).

Manganese (Mn) is compulsory for growth, digestion and reproduction in ruminants. Retarded growth and poor ossification and high rate of bone fractures were noted in ewes raised on low manganese diets (Grace and Knowles, 2012; Uslu *et al*., 2017). Selenium (Se) is a cell antioxidant, which prevents harm of free oxygen and several peroxides formed from fatty acids (Gürdoğan *et al*., 2006; Ganie *et al*., 2014; Makhlouf *et al*., 2020). Body condition score, lambing rate has amplified with selenium supplementation (Vázquez-Armijo *et al*., 2011; Awawdeh *et al*., 2019). Iron (Fe) occurs in major quantities in blood and muscle as well as in many enzymes (Zhang *et al*., 2018). Zinc (Zn) is indispensable in the production of many of the sex hormones, comprising enzymes, steroid hormones and GnRH (Stefanidou *et al*., 2006; Nielsen, 2012).

There are several factors affecting the dynamic changes in the level of trace elements in the serum of sheep among them seasonality, sex, pregnancy, litter size and type of feeding (Grace and Knowles, 2012; Nawito *et al*., 2015; Makhlouf *et al*., 2020). Therefore, we hypothesize that before ration formulation and calculating the minimum requirement of these elements in feed these factors should be considered. The aim of this study was to investigate the effect of the breed, parity, age, body condition score, housing and feeding type on the serum level of trace elements of breeding ewes in Qassim region, central Saudi Arabia.

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MATERIALS AND METHODS

This study was carried out at Qassim veterinary hospital (autumn/winter breeding seasons of the year 2020/2021). Total of 131 breeding ewes averaged 3.73 years age and 53.87 kgs weight in Qassim region, central Saudi Arabia, longitude 43-58°E and latitude 21-26°N were used in this study. Diets were formulated to meet or exceed the requirements of 50 kg maintenance ewe according to NRC for sheep (1985). The average daily feed intake was ranged from 1250- to 1350 g/head/day and drinking water ad libitum. Animals were categorized according to breed (Awassi, n=49 vs Harry, n=36 vs Hybrid, n=32 vs Najdi n=14), Age, parity, body condition score (1-5 where 1 is skinny and 5 is overfed), feeding type [barseem, n=66 vs barseem+feed pellets (Table 1 shows the amount/percentage of nutritional ingredients in

these pellets according to the manufacturer's prescription), n=10 vs barley, n=22 vs Barley + pellets, n=33], housing (open, the ewes were left unconfined in open areas, n=34 vs. closed, ewes were kept throughout the day and night in pens, n=44 vs. mixed, ewes were left free during the day and kept in pens at night, n=53).

The animals were examined clinically for general health condition and thriftiness. For the gynecological examination, transrectal/Transabdominal ultrasonography using a 5 MHz probe (Aloka Co., Ltd., Tokyo, Japan) was carried out. Only healthy, sound and non-pregnant ewes were used in the present study.

Blood was collected from the jugular vein of all studied ewes. The serum samples were separated by centrifugation for 10 min at 1200xg and were immediately frozen till the time of assay.

Serum was digested using HClO4-HNO3 mixture, according to the technique described previously (Antoniou *et al.*, 1995). Concentrations of Mn, Se, Fe and Zn were determined by flame emission atomic absorption (Thermo Scientific, Mosel:iCAP 7400 Duo, USA) based on the previously described technique (Moffat *et al.*, 1986).

The data were presented in means ± SE and statistical analysis was carried out using the SPSS program, version 25 (SPSS Inc., Chicago, IL, USA, 2017). Data were analyzed by the GLM procedures for the effect of different factors on the serum concentration of trace elements in ewes. Relationships were estimated by the correlation coefficient. Significance was set at P<0.05.

Table 1: Amount/percentages of nutrients in feed pellets used for feeding breeding ewes in Qassim region.

Ingredients	Amount or %
Crude protein (%)	11.25%
Nitrogen (%)	1.8
Phosphorus (%)	0.3
Acid Detergent Fiber (%)	27
Zinc (PPM)	30
Iron (PPM)	110
M.E. (MJ/Kg)	11
Potassium (%)	0.7
Sodium (%)	0.3
Calcium (%)	0.6
Manganese (ppm)	40

RESULTS AND DISCUSSION

Breed had a significant effect on Se (P=0.001), Fe (P=0.009) and Zn (P=0.045). Awassi breed had higher levels of Se, Fe and Zn than other breeds (Table 2). Parity had a significant effect on serum Se (P=0.03), Fe (P=0.01) and Zn (P=0.02) (Table 3). Serum Mn (P = 0.003), Se (P = 0.001) and Fe (P=0.001) levels were affected by the type of feeding. Ewes fed on barseem had lower serum Mn (Table 4). Positive correlation between parity and Se (P=0.015) and parity and Fe (P=0.02) were found.

Breed, parity and type of feeding had a significant effect on Serum Se in the present study. The effect of genetic predisposition on the level of trace elements has been discussed and a strong relationship between the human race or animal species with the level of trace elements was found. Selenium is reportedly associated with the formation of histones and DNA (Hosnedlova *et al.*, 2017). The genotype of an animal affects its energy and protein requirements (Sahlu *et al.*, 2004), Awassi ewes had a distinguished profile of serum trace elements compared to other breeds in the present study. Awassi breed have been found to be more adaptable to arid conditions than other breeds in Saudi Arabia (Abdelqader *et al.*, 2012; Ali *et al.*, 2020).

Table 2: The effect of breed on the level of serum manganese (Mn), selenium (Se), iron (Fe) and zinc (Zn) of ewes.

Breed	n	Mn (mg/L)	Se (mg/L)	Fe (mg/L)	Zn (mg/L)
Harry	36	2.71±0. 23^{a}	0.41±0.05 ^{a}	6.64±0.71^{a}	3.88±0.49^{a}
hybrid	32	3.53±0.58^{a}	0.80±0.08 ^{a}	8.26±1.94^{a}	9.92±3.19^{b}
Najdy	14	3.01±0.57^{a}	0.51±0.04 ^{a}	8.18±0.96^{a}	5.10±0.63^{a}
Awassi	49	5.21±3.59^{a}	4.24±3.65 ^{b}	12.03±1.41^{b}	10.66±3.56^{b}

Values are presented as means±standard error. Values with the same superscript letter in the same column are not significantly different. Statistical significance was set at *P*<0.05.

Table 3: The effect of parity on the level of serum manganese (Mn), selenium (Se), iron (Fe) and zinc (Zn) of ewes.

Parity	n	Mn (mg/L)	Se (mg/L)	Fe (mg/L)	Zn (mg/L)
0	23	2.01±0.54^{a}	0.25±0.01^{a}	5.93±0.12^{a}	2.29±0.08^{a}
1	29	3.60±0.31^{a}	0.37±0. 03^{a}	9.53±0.28^{a}	3.84±0.04^{a}
2	31	3.05±0.41^{a}	0.50±0.02^{a}	7.61±0.93^{a}	7.19±1.54^{a}
3	21	2.58±0.23^{a}	0.58±0.07^{a}	8.80±0.87^{a}	5.61±0.87^{a}
4	16	3.99±0.35^{a}	1.87±0.09^{b}	7.75±0.76^{a}	6.26±1.37^{a}
>5	11	4.32±1.05^{a}	0.72±0.05^{a}	14.41±1.23^{b}	15.79±3.28^{b}

Values are presented as means ± standard error. Values with the same superscript letter in the same column are not significantly different. Statistical significance was set at P<0.05.

Older ewes had a higher Zn level than younger ones (Table 7). Age (P=0.001), BCS (P=0.008) and Parity (P=0.03) had positive effects on Zn. Earlier reports indicated that the level of trace elements is significantly influenced by parity of sheep and goats (Gürdogan *et al.*, 2006). Accordingly, levels of serum Se, Fe and Zn were higher in older and multiparous ewes. Although there is a concept that maternal stores of minerals deplete with age and repeated pregnancies, the fact that most minerals increase in older females is undeniable (Singh *et al.*, 2010). The higher demand of nutrition during pregnancy and associated increase in metabolic processes including mobilization of the trace elements from the maternal tissue to the circulation during pregnancy is probably sustainable after birth (Ugwuja *et al.*, 2015; Kumar *et al.*, 2011). The affordable food quantity and quality improve during pregnancy as a part of the regular routine management which may explain the increasingly high levels of trace elements with increased parity (Kumar *et al.*, 2017).

Although forages are rich in trace elements, their formulation and contents are affected by the type of soil where they grow. Concentrations of these elements in soil and their availability in plants affect their richness in the crop and the amount detected in green substance and seeds as well. Hence, many concerns about the animal's productive and reproductive performance arise from the type of soil where cultivation takes place (Hill and Shannon, 2019). Barseem cultivated in semiarid, arid and reclaimed soils, as the case in Qassim region, characterized by lower Mn, Cu and Fe contents (Nawito *et al.*, 2015). It has been illustrated that the metal build-up in the aforementioned soils is not high enough to cause considerable accumulation of these trace elements in barseem roots, probably due to high oxides in soils, which play a great role in reducing their availability (Grace and Knowles, 2012; Abuzaid *et al.*, 2021; Al-Turki *et al.*, 2020). It is generally accepted that most of the Arabian Peninsula is suffering from trace elements imbalance (Ali *et al.*, 2021).

Animals housed in closed pens had lower serum Zn (P=0.03) values than those managed in open and mixed management system (Table 5). Housing and BCS of the studied ewes affected significantly serum Zn level. Ewes housed in confined pens showed lower serum Zn levels. It is accepted that feed availability and quality provided to the animals depends solely on the individual awareness of the breeder and his knowledge (Dhok and Rekhate, 2008; Kumar *et al.*, 2017). The vast majority of managers are illiterate or averagely educated (Ali *et al.*, 2020). It is not surprising that most of the animals in closed pens receive inadequate amounts of trace elements despite the fact that they receive the adequate amount of feed for maintenance. It was interesting enough to find that more than 80% of ewes managed in closed pens fed only Barseem.

Serum Zn increased significantly (P=0.008) in ewes with body condition score 4 (Table 6). There was a positive correlation between BCS and Zn in this study. In modern

Table 4: The effect of feeding type on the level of serum manganese (Mn), Selenium (Se), iron (Fe) and Zinc (Zn) of ewes.

Breed	n	Mn (mg/L)	Se (mg/L)	Fe (mg/L)	Zn (mg/L)
Barseem	66	2.22±0.25^{a}	0.52±0.04^{a}	9.21±0.63^{a}	4.75±0.35^{a}
Pellets + Barseem	10	5.2±1.31^{b}	2.44±1.43^{b}	10.33±2.16^{a}	8.78±1.64^{a}
Barley	22	4.46±2.61^{b}	0.8±0.01^{a}	29.05±7.54^{b}	8.21±2.35^{a}
pellets + barley	33	3.71±0.45^{b}	0.49±0.06^{a}	6.76±1.25^{a}	7.06±2.26^{a}

Values are presented as means ± standard error. Values with the same superscript letter in the same column are not significantly different. Statistical significance was set at P<0.05.

Table 5: The effect of housing system on the level of serum manganese (Mn), selenium (Se), iron (Fe) and zinc (Zn) of ewes.

Housing system	n	Mn (mg/L)	Se (mg/L)	Fe (mg/L)	Zn (mg/L)
Closed	44	2.13±0.18^{a}	0.41±0.04^{a}	7.60±1.18^{a}	4.08±0.52^{a}
open	14	3.74±0.76^{a}	0.67±0.06^{a}	7.54±1.20^{a}	9.57±1.13^{b}
Mixed	73	3.54±0.41^{a}	0.80±0.21^{a}	9.41±0.98^{a}	6.55±1.63^{b}

Values are presented as means ± standard error. Values with the same superscript letter in the same column are not significantly different. Statistical significance was set at P<0.05.

Table 6: The effect of body condition score (BCS) on the level of serum manganese (Mn), selenium (Se), iron (Fe) and zinc (Zn) of ewes.

BCS	n	Mn (mg/L)	Se (mg/L)	Fe (mg/L)	Zn (mg/L)
2.5	18	2.05±0.61^{a}	0.83±0.09^{a}	8.37±1.61^{a}	10.28±3.61^{a}
3	71	3.00±0.42^{a}	0.66±0.05^{a}	8.51±1.45^{a}	5.45±1.73^{a}
3.5	27	2.59±0.81^{a}	0.49±0.07^{a}	8.90±1.94^{a}	5.48±1.54^{a}
4	15	4.64±0.93^{a}	0.59±0.04^{a}	10.49±2.21^{a}	19.23±3.78^{b}

Values are presented as means ± standard error. Values with the same superscript letter in the same column are not significantly different. Statistical significance was set at P<0.05.

Table 7: The effect of age on the level of serum manganese (Mn), selenium (Se), iron (Fe) and zinc (Zn) of ewes.

Age (year)	n	Mn (mg/L)	Se (mg/L)	Fe (mg/L)	Zn (mg/L)
1->2	13	1.64±0.54[a]	0.14±0.04[a]	4.15±0.63[a]	3.28±2.61[c]
2->3	15	3.11±0.61[a]	0.59±0.06[a]	10.53±1.94[a]	3.49±1.45[a]
3->4	32	3.19±0.81[a]	0.81±0.07[a]	10.31±0.93[a]	5.90±0.18[a]
4->5	39	2.30±0.63[a]	0.52±0.01[a]	10.32±1.45[a]	6.40±0.78[a]
5->6	22	3.59±0.35[a]	0.64±0.09[a]	8.52±0.12[a]	6.79±0.35[a]
≤ 6	10	4.46±0.41[a]	0.63±0.05[a]	9.61±1.73[a]	19.12±1.31[b]

Values are presented as means±standard error. Values with the same superscript letter in the same column are not significantly different. Statistical significance was set at P<0.05.

technology of sheep production, the determination of nutritional requirements and formulation of ration depend on monitoring the BCS (Zhang *et al*., 2018; Makhlouf *et al*., 2020). As parts of the enzymatic build-up requirements, Zn and Se are involved in different anabolic processes and cytogenetic activities which may clarify their relation with food conversion and body transformation (Ugwuja *et al*., 2015).

CONCLUSION

It can be concluded that the level of trace elements in breeding sheep is affected by breed, parity, age, body condition score, housing and type of feeding in central Saudi Arabia. Based on the results of the present study, it is recommended that barseem only should not be rely on as a source of trace elements for breeding ewes in arid and semiarid areas.

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