J Biochem Tech (2020) 11(4): 20-23
ISSN: 0974-2328

Exchange of Cobalt in the Body of Lactating Fat-Tailed Ewes and Its Intake Rates

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Received: 02 July 2020 / Received in revised form: 03 October 2020, Accepted: 14 October 2020, Published online: 28 November 2020

Abstract

The optimal intake rates of cobalt for lactating meat-greasy ewes were calculated in the context of the arid zone of Russia using a factorial method based on the concentration of this microelement in the organs and tissues, in the chyme, and gastrointestinal tract, as well as the degree of intake of this micronutrient from rations and endogenous losses with feces, urine, and milk. It was revealed that during lactation, the intensity of cobalt metabolism in the body of ewe increased significantly. The daily requirement of lactating ewes in this element, determined in the course of study, was as follows: in the first half of lactation, they had to be fed 1.6 mg of cobalt per head per day, while per one kg of dry matter of the ration – 0.53 mg, and per one kg of live weight – 0.03 mg. In the second half of lactation, these figures should be 1.3, 0.47, and 0.02 mg, respectively.

Keywords: lactating ewes, organs, and tissues, cobalt concentration, element, the rate.

Introduction

Improving health and having a healthy lifestyle is important for societies that are trying to advance and develop strategies for sustainable development, and refrain from allocating budgets to lifestyle diseases (Algahtani, 2020; Antony & Azeem, 2019; Sundus, 2018; Bottalico, 2020).

Cobalt is one of the vital micronutrients for farm animals since it takes an active part in hematopoiesis, and the synthesis of the B_{12} vitamin, whose part it is. Sheep need this micronutrient for normal activity of the rumen microflora, rumen digestion, and digestibility of feed nutrients. Cobalt deficiency leads to severe disease. Due to the low intake of cobalt, the microflora of the sheep's rumen undergoes a qualitative change, its amount sharply reduces. In this regard, the synthesis of B_{12} vitamin in the rumen is inhibited, and its content in organs and blood decreases, which leads to a violation of hematogenesis and metabolic processes (Lapshin, 1979). Therefore, it is very important to control the intake of cobalt into the body of animals, taking into account its content in the feed ration. However, the existing recommendations of the Russian Academy of Agricultural Sciences (Kalashnikov et al., 2003) on mineral feeding of sheep do not provide for zonal features of animal breeding. The rates of micronutrients for lactating meat-greasy ewes given in these recommendations are the same as for wool and wool-meat breeds (Mandzhiev et al., 2019).

Therefore, there is a need to develop intake rates for this element, which would take into account the zonal features of breeding and animal productivity specifics.

Taking into account these circumstances, the purpose of the present work is to study the exchange of cobalt and develop intake rates for lactating meat-greasy ewes at the beginning and end of lactation in the context of the arid zone.

Methods

Physiological studies were carried out in the production environment of the Budda peasant farm economy on lactating ewes of the Kalmyk fat-tailed breeds at the beginning and end of their lactation. For the study, three heads of animals of each lactation period were taken with a live weight of 58-60 kg. During the experiment, the animals were kept in individual cages, and fed according to the feeding rates recommended by the Russian Academy of Agricultural Sciences (Kalashnikov et al., 2003), taking into account the chemical composition of local feeds.

In the first half of lactation, the ration consisted of cereals and *motley grass* in the amount of 8 kg, alfalfa hay – 200 g, barley groats – 100 g, fine salt – 15 g, copper sulfate – 52 mg, zinc sulfate – 476 mg, manganese sulfate – 48 mg, and cobalt chloride – 4 mg. The ration contained 1.3 mg of cobalt. In the second half of lactation, the ration consisted of cereals and *motley grass* – 8 kg, barley groats – 100 g, fine salt – 14 g, copper sulfate – 49 mg, zinc sulfate – 406 mg, and 2.9 mg of cobalt chloride. The ration contained 0.95 mg of cobalt.

To study the amount of cobalt contained in organs and tissues, as well as in the body of ewes in general, all ewes were slaughtered on the day of the end of each balance experiment. At that, the weight of organs and tissues, parts of the digestive tract of ewes, and their contents were determined. The concentration of cobalt in organs and tissues, in the sections of the gastrointestinal tract and their contents, as well as in samples of balance experiments was determined using an atomic absorption spectrometer.

The calculation of the demand of ewes for cobalt was carried out by the factorial method. To do this, the total content of this element

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in the body of ewes during different periods of their lactation was determined. Then the amount of cobalt that was deposited in the body of ewes during the entire lactation period and per day was measured. Endogenous losses of this element with urine and milk were determined by the direct method, while in feces – according to (Georgievsky et al., 1979).

The revealed daily deposition of cobalt in the ewe's body, as well as endogenous losses of this element with feces, urine, and milk, were summed up to determine the true daily need for the studied element.

Based on the results of balance experiments, and taking into account endogenous losses with feces, the true digestibility of cobalt from rations was calculated using the following formula:

$$D = \frac{I-(R-E)}{I} \times 100$$

where: *D* was the true digestibility, %; *I* was the intake of the element with the ration, g; *R* was the release of the element with the feces, g; *E* was the endogenous losses with feces, g.

The established total true requirement for the element was divided by the percentage of true digestibility to determine the amount of cobalt that should be contained in the ration.

The digital material of the experiments was processed biometrically, according to the method of E.K. Merkuryeva (1970).

Results

The data obtained in the experiment indicate that of all the tissues of lactating ewes, kidney suet and interior fat, skin with a coat, and bone tissue are especially rich in cobalt, while blood, muscle tissue, and brain are relatively poor in cobalt. During the lactating period of ewes, the concentration of cobalt in the kidney suet ranged from 6.555 to 8.491 mg/kg fresh weight, in the interior fat – from 1.885 to 2.867 mg/kg, in the skin with the coat – from 2.297 to 2.803 mg/kg, in the bone tissue – from 1.628 to 1.681 mg/kg, in the brain – from 0.731 to 0.703 mg/kg, in the muscle tissue – from 0.638 to 0.828 mg/kg, and in the blood – from 0.100 to 0.166 mg/kg (Table 1).

The lactation period had a different effect on the total content of cobalt in these tissues (Table 2). Thus, during the lactation period, it's content in the blood increased by 57%, in the muscle tissue – by 22.9%, and in the skin with the coat – by 12.6%. In the bone and fat tissues, as well as the brain, the total amount of the element remained without significant changes.

The study of the chemical composition of internal organs makes it possible to reveal the essence of intermediate metabolism, which is based on numerous reactions of synthesis, decomposition, and transformation of substances that continuously occur in the organs, tissues, and fluids of an animal in the course of its life activities (Mandzhiev and Gayirbegov, 2019). Taking this into account, the authors have also studied the content of cobalt in the internal organs of lactating ewes. The results of the analysis of the samples of internal parts have shown that the highest concentration of this element was detected in the spleen, which contained from 42.372 to 58.129 mg/kg fresh weight of cobalt. The rest of the internal parts of the body in terms of the concentration of this element were arranged in the following descending order: liver – kidneys – heart – lungs. By the end of the lactation period, there was an increase in the total cobalt content in the heart by 51% ($p<0.001$), in the lungs – by 39.6% ($p>0.05$), in the liver – by 11.4% ($p<0.01$), in the kidneys – by 21.9% ($p>0.05$), and in the spleen – by 45.98% ($p<0.01$).

The relatively high concentration of cobalt was also found in the uterus and udder. During the lactation period of ewes, it increased 2.3 times in the uterus ($p<0.01$), 2.5 times in the udder ($p<0.001$), while the total amount of this element in these organs practically remained at the same level and did not depend on the lactation period: (7.35-7.60 mg) and (4.20 - 4.40 mg), respectively.

The digestive tract plays an important role in the metabolism of minerals, including cobalt and its regulation in ruminants. Therefore, data on the content of this element in various parts of the gastrointestinal tract are of particular interest. In the present studies, the highest concentration of cobalt was detected in both the manifold itself (23.196-36.522 mg/kg) and its contents (42.463 -62.728 mg/kg) that can probably be explained by the lower moisture content of the chyme, as well as the predominance of the secretion process.

Table 1. The concentration of cobalt in the body of lactating ewes, mg/kg fresh weight

Organs and tissues	Lactation periods	
	First half	Second half
1	2	3
Blood	0.100±0.01	0.166±0.04
Muscle tissue	0.638±0.01	0.828±0.02
Bone tissue	1.628±0.03	1.681±0.07
Skin with coat	2.297±±0.03	2.803±0.05
Interior fat	1.885±±0.14	2.867±0.03
Kidney suet	6.555±1.12	8.491±0.80
Brain	0.703±0.03	0.731±0.02
Tongue	20.141±1.08	128.016±7.12
Heart	8.808±0.80	13.056±0.82
Lungs	5.048±0.16	6.760±1.59
Liver	22.300±3.53	21.432±0.54
Kidneys	13.709±1.31	16.306±0.56
Spleen	42.372±4.11	58.129±4.57
Uterus	23.126±1.66	54.429±4.73
Udder	6.471±0.31	16.280±0.52
Rumen	0.903±0.03	3.135±0.11
Fore stomach	12.770±0.37	13.502±±0.50

Manifold	23.196±1.22	36.522±1.74
Abomasum	3.393±0.03	3.779±0.19
Small intestine	0.706±0.03	3.930±0.38
Large bowel	1.326±0.06	3.12±0.14
Contents of:		
Rumen	2.169±0.08	2.305±0.03
Fore stomach	1.649±0.13	1.711±0.04
Manifold	42.463±1.90	62.728±0.76
Abomasum	0.778±0.03	0.527±0.07
Small intestine	15.698±0.39	19.524±0.27
Large bowel	23.151±1.22	24.643±0.83
Fat-tail	0.222±0.04	0.243±0.01

A high concentration of cobalt was also observed in the forestomach, which contained from 12.770 to 13.502 mg/kg fresh weight of cobalt. The lowest concentration of the element was detected in the rumen (0.903-3.135 mg/kg) and abomasum (3.393 - 3.779 mg/kg).

Table 2. The total amount of cobalt in the body of lactating ewes, mg

Organs and tissues	Lactation periods	
	First half	Second half
1	2	3
Blood	0.42±0.02	0.66±0.02
Muscle tissue	10.90±0.13	13.40±0.50
Bone tissue	12.70±0.35	12.40±0.18
Skin with coat	14.92±0.24	16.80±0.23
Interior fat	0.60±0.02	0.63±0.01
Kidney suet	0.84±0.03	0.84±0.03
Brain	0.094±0.02	0.095±0.01
Tongue	1.95±0.07	11.99±0.29
Heart	2.45±0.14	3.70±0.06
Lungs	2.83±0.14	3.95±1.03
Liver	16.52±0.25	18.40±0.28
Kidneys	1.60±0.13	1.95±0.03
Spleen	3.77±0.15	5.50±0.28
Uterus	7.35±020	7.60±0.23
Udder	4.20±0.14	4.40±0.20
Rumen	1.12±0.04	3.70±0.15
Fore stomach	1.98±0.07	2.30±0.15
Manifold	4.13±0.24	6.13±0.23
Abomasum	1.90±0.04	2.19±0.10
Small intestine	0.91±0.04	4.70±0.40
Large bowel	1.39±0.04	3.44±0.24
Contents of:		
Rumen	15.62±0.31	17.52±0.28
Fore stomach	0.61±0.03	0.65±0.03
Manifold	10.191±0.71	13.17±0.13
Abomasum	0.28±0.01	0.20±0.02
Small intestine	13.50±0.28	16.40±0.30
Large bowel	12.27±0.10	13.80±0.20
Fat-tail	0.93±0.04	0.97±0.02
Total in the body	145.995	177.495

As for the chyme of these stomach parts, in the course of lactation of ewes, the concentration of the element in the content of the rumen and forestomach increased by 6.3 and 3.7%, respectively, while in the abomasum, on the contrary, decreased by 32.3%.

In the small intestine and its contents, the concentration of cobalt increased in the course of lactation of ewes by 5.56 and 1.24 times ($p<0.001$).

The increase in the content of cobalt in the large bowel was more noticeable and this difference was most significant at the end of the lactation period, which indicated a decrease in the absorption of cobalt and an increase in the excretion of the element with feces.

Generally, the total amount of cobalt in the gastrointestinal tract depends on both the increase in the weight of the stomach parts and their contents, as well as the concentration of the element in these parts. During lactation, the total amount of this element in the rumen increased 3.3 times ($p<0.001$), in the forestomach – 1.16 times, in the manifold – 1.48 times, in the abomasum – 1.15 times, in the small intestine – 5.16 times, and in the large bowel – 2.47 times. The total amount of this element in the contents of the small intestine exceeded that in the large bowel at the beginning of lactation by 10% ($p<0.05$), while at the end of lactation – by 18.8% ($p<0.01$).

Table 3. The daily requirement of lactating ewes in cobalt, mg

Indicators	Lactation periods	
	First half	Second half
1	2	3
The total amount of cobalt in the body:		
- at the beginning of the period	113.495	145.995
- at the end of the period	145.995	177.495
The total amount of cobalt in the body for the period	32.5	31.5
Daily deposition of cobalt in the body of lactating ewes, mg	0.65	0.45
Endogenous losses with:		
- feces	0.18	0.17
- urine	0.09	0.07
- milk	0.05	0.05
- total	0.32	0.29

The true daily rate in cobalt	0.97	0.74
True digestibility of cobalt from the ration, %	60.78	57.0
The daily rate of cobalt:		
- per head per day	1.60	1.30
- per one kg of dry matter of the ration	0.53	0.47
- per one kg of live weight	0.03	0.02

In the contents of the gastrointestinal tract, in the first half of lactation, the total amount of cobalt in the rumen of ewes accounted for 29.77%, in the forestomach – for 1.16%, in the manifold – for 19.42%, in the abomasum – for 0.53%, in the small intestine – for 25.73%, and in the large bowel – for 23.38%, while in the second half of lactation, these figures were 28.38, 1.05, 21.33, 0.32, 26.56, and 22.35%, respectively.

The total amount of cobalt in the body of ewes in the first half of lactation was 145.995 mg, while in the second half of lactation – 177.495 mg.

According to the results of the previous studies conducted by the authors, the total amount of cobalt in the body of ewes at the end of their pregnancy amounted to 113.495 mg (Mandzhiev et al., 2019). It was also revealed that the daily deposition of this element in the body of ewes during lactation decreased by 30.8%. Besides, endogenous losses of cobalt with feces, urine, and milk also decreased by 9.6% (Table 3). The conducted calculations have also shown that the total true daily requirement of the lactating ewes in cobalt in the periods of lactation was 0.97 and 0.74 mg, respectively.

Conclusion

Taking into account the fact that cobalt is absorbed from rations at 60.78 and 57.0%, lactating meat-greasy ewes should receive the following amount of this element with a daily ration: in the first half of lactation – 1.6 mg, in the second half of lactation – 1.3 mg. These figures per one kg of dry matter of the ration are respectively 0.53 and 0.47 mg, while per one kg of live weight – 0.03 and 0.02 mg.

References

Algahtani, F. D. (2020). Healthy Lifestyle among Ha'il University Students, Saudi Arabia. *International Journal of Pharmaceutical Research & Allied Sciences, 9*(1), 160-167.

Antony, V. C., & Azeem, K. (2019). Health-Related Quality of Life among Saudi Undergraduate Students with Different Categories of Body Mass Index. *International Journal of Pharmaceutical Research & Allied Sciences, 8*(2), 15-21.

Bottalico, L., Castellaneta, F., & Charitos, I. A. (2020). From hydrotherapy to the discovery of the gut microbiota: the historical gastrointestinal health concept. *Pharmacophore, 11*(2), 82-90.

Georgievsky, V. I., Annenkov, B. N., & Samokhin, V. T. (1979). Mineral nutrition of animals, Moscow: Kolos.

Kalashnikov, A. P., Fisitnina, V. I., Shcheglova, V. V., & Kleymenova, N. I. (2003). Feeding rates and rations of agricultural animals. Reference book, Moscow.

Lapshin, S. A. (1979). Rational feeding of sheep based on industrial technology, Saransk: Mordovian Book Publishers.

Mandzhiev, D. B., & Gayirbegov, D. Sh. (2019). Rate setting of copper in rations of lactating ewes of the Kalmyk fat-tailed breed, *Agricultural Research Journal, 2*, 37-40.

Mandzhiev, D. B., Gayirbegov, D. Sh., & Simonov, G. A. (2019). Substantiation of the need of fat-tailed pregnant ewes in cobalt, *Annals of Agri Bio Research, 24*(2), 332-337.

Merkuryeva, E. K. (1970). Biometrics in breeding and genetics of farm animals, Moscow: Kolos.

Sundus, A., Ismail, N. E., & Gnanasan, S. (2018). Exploration of healthcare practitioner's perception regarding pharmacist's role in cancer palliative care, Malaysia. *Pharmacophore, 9*(4), 1-7.