

Full Length Research Paper

The content of mineral elements on whole blood and hair in *Moschus sifanicus*

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The mineral content of forage, whole blood and hair samples of *Moschus sifanicus* were analyzed and compared with those of local goats. The results indicated that the selenium content of 10 kinds of foliage was lower than the nutrient standards set for herbivores by the National Research Council. The Cu, Mn, Zn, Ca and Mg content of hair was significantly higher than those in whole blood; however, Fe content was the reverse. All elements had concentration distribution, and the variation of mineral content in whole blood and hair of *M. sifanicus* was small.

Key words: *Moschus sifanicus*, blood and hair, mineral elements.

INTRODUCTION

Moschus sifanicus are small ruminants and belong to the Cetartiodactyla order of the deer family and musk subfamily (Figure 1). Most of them inhabit China, Burma, Northern India, Northern Vietnam and the Himalayan region (Green, 1986). For a long time, the musk deer have been kept for the acquirement of the musk secreted by the musk gland in male, which is one of the oldest raw materials used in the perfumery industry because of its fixative and scent properties. *M. sifanicus* is mainly distributed in Qinghai, Gansu, Xizang, Ningxia, Sichuan and Yunnan Province, China (Yang et al., 2002; Zheng et al., 1979; Sheng, 1992). It was listed in the first category of the Chinese State Key Protected Wildlife List in 2002.

M. sifanicus is an important economic and medicinal animal which is distributed in Xinglongshan National Nature Reserve of Gansu Province of China. Some of the ecological habits and disease prevention of the domesticated *M. sifanicus* have already been reported (Jiang, 1998; Meng et al., 2002; Lu et al., 2004, 2008, 2010). To ensure the development of captive *M. sifanicus*, provide the values needed in health care as well as disease prevention and treatment, fill the gaps in the basic study of wild *M. sifanicus*, the content of six micro elements (Cu, Mn, Fe, Zn, Mo and Se) and two

macro elements (Ca and Mg) in the whole blood and hair of 15 healthy *M. sifanicus* were determined.

MATERIALS AND METHODS

Fifteen healthy *M. sifanicus* (sexuality: 13 male and 2 female; age: 12 aged 1 to 3 and 3 aged 4 to 7), were selected randomly from the Breeding Center of *M. sifanicus* in the Xinglongshan National Nature Reserve.

Fifteen local goats which were grazed in the same forest with *M. sifanicus*; 10 male and 5 female, aged 2 to 4 years, were selected.

Forage

Ten wild plants, distributed widely in Xinglongshan National Nature Reserve, are the main local resource of forage for *M. sifanicus*.

Collection and treatment of samples

Animal samples

The hair samples were collected from the neck of the animals, put in paper bags respectively, soaked and washed in the 1% liquefied detergent, rinsed several times in tap water and defatted by diethyl ether, dried in 80°C drying oven, and preserved in dried plate. The blood samples were collected from jugular veins, and then anticoagulated with 1% heparin sodium and cold preserved.

Plant samples

The edible part (leaves) of the 10 plants (*Spiraea myrtilloides*,

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Figure 1. *M. sifanicus*.

Cornus bretschneideri, *Lonicera chrysantha*, *Cerasus tomentosa*, *Lonicera ferdinandii*, *Crataegus kansuensis*, *Acer tetramerum* var. *betulifolium*, *Prunus salicina*, *Corylus mandshurica* and *Tamarix ramosissima*) were collected; 1000 g from each plant, weighted, dried in the shade ground and then shattered to pass through a 40 mesh sieve, made into analysis samples and preserved dry.

Macro and trace elements determination of samples

The trace elements: Copper (Cu), iron (Fe), manganese (Mn), selenium (Se), molybdenum (Mo) and zinc (Zn), and the major elements: Calcium (Ca) and magnesium (Mg) of the samples were subsequently measured by inductively coupled plasma mass spectrometry, and the parameters are shown in Table 1 (ICP-MS; Perkin- Elmer SCIEX ELAN 6000, Perkin Elmer Corp., Norwalk, CT, USA). For the proposed method, samples were digested in closed-vessels with a microwave oven decomposition system (Milestone ETHOS 1600) according to the following procedure: The samples of about 0.1 g were weighed (wet weight) and put in quartz tubes and then 0.5 mL of 65% nitric acid/0.1 g sample wet weight were added. In addition, 0.5 mL of 30% ultrapure hydrogen peroxide was added to the samples (Merck, Darmstadt, Germany). The tubes were then sealed with a Teflon lid and put into the steel bombs which were sealed with exactly the same momentum. The bombs were then heated in an oven to 180°C for 4 h. After that, the digestate were left to cool and then the volume was made up to 10 mL with Milli-Q

water.

Statistical analysis

Differences of the data were assessed by Student's *t*-test.

RESULTS

The content of macro elements and micro elements in the 10 forages, the whole blood and hair of *M. sifanicus* are shown in Tables 2 to 4. The average content of Se in the forages is 0.1352 $\mu\text{mol/L}$, which is significantly lower than the standard content, which has been reported as 1.27 $\mu\text{mol/L}$ (Zhai, 1984). The content of Cu, Mn, Zn, Ca and Mg in the hair was significantly higher than that in whole blood, while the content of Fe was the reverse.

The mineral contents of whole blood and hair of *M. sifanicus* were compared with that of local goats by *t*-test of the comparison group match, the result shows that there was interspecific difference of the mineral content in some elements between *M. sifanicus* and local goats, and the difference was extremely significant in the content of Cu, Ca and Mg ($p < 0.01$). Besides, all

Table 1. ICP-MS operating conditions.

Operating parameter	Parameter value
Power / W	1250
Plasma gas flow / L min ⁻¹	15
Auxiliary gas flow / L min ⁻¹	1.35
Nebulizer gas flow / L min ⁻¹	0.96
DRC mode nebulizer gas flow / L min ⁻¹	0.95
Cell gas A / mL min ⁻¹	1

Table 2. The content of trace elements in the plants preferred by *M. sifanicus* (X±SD).

Item	Ca (mmol/L)	Mn (mmol/L)	Zn (μmol/L)	Se (μmol/L)
Preferred plants	683.75 ± 227.5	1.635 ± 0.74	0.537 ± 0.15	0.352 ± 0.46
Local pasture	128.382 ± 49.09	*	0.304 ± 0.19	0.215 ± 0.02
Soil	167.252 ± 21.25	*	1.882 ± 0.18	0.215 ± 0.02

* Undetermined items.

Table 3. The content of 8 mineral elements in the blood of *M. sifanicus*.

Element	<i>M. sifanicus</i>		Local goat	
	(X ± SD)	Range	(X ± SD)	Range
Cu (μmol/L)	1.909 ± 1.37	0.973 ~ 4.835	0.983 ± 0.301	0.528 ~ 1.581
Mn (μmol/L)	3.656 ± 0.86	2.766 ~ 5.405	*	*
Fe (mmol/L)	11.36 ± 3.354	6.383 ~ 21.811	7.602 ± 1.965	5.831 ~ 11.239
Zn (μmol/L)	0.108 ± 0.001	0.063 ~ 0.003	0.186 ± 0.079	0.112 ~ 0.288
Ca (mmol/L)	0.928 ± 0.262	0.395 ~ 1.18	4.538 ± 0.574	3.458 ~ 5.58
Mg (mmol/L)	1.618 ± 0.189	1.264 ~ 1.988	1.489 ± 0.196	1.097 ~ 1.697
Se (μmol/L)		*	0.924 ± 0.392	0.481 ~ 1.709
Mo (μmol/L)	0.106 ± 0.06	0.01 ~ 0.21	5.158 ± 0.906	3.73 ~ 6.189

* Undetermined items.

elements had concentration distribution in the whole blood and hair of *M. sifanicus*. The dispersions of elements distribution in the whole blood and hair of *M. sifanicus* were small, except for Mo, the maximum of which was 21 times higher than the minimum value (the others were below 4 times).

DISCUSSION

To provide the reference values needed in the breeding and disease diagnosis, prevention and treatment, and fill the gaps of information of physiology and biochemistry in wild *M. sifanicus*, the content of six micro elements and two micro elements in the whole blood and hair of 15 healthy *M. sifanicus* were determined and reported in this paper. However, because of the limited samples and the lack of other related references, the results can only be used for reference, and further study is needed.

Mineral element is an essential nutrient substance in

the growth development and substance metabolism of animals. The contents of micro element are very small, but they have many biological functions, such as regulating enzymatic reaction, promoting micro elements transport, involved in hormone synthesis and forming some nutrients (Linder, 1985). During the breeding process, the content of mineral elements in *M. sifanicus* can be influenced by the change of forage. In this experiment, hair and blood samples were collected to detect the mineral content of *M. sifanicus* and provide reference values to establish the breeding standard. The aim of this paper is to establish proper dietary recipe for *M. sifanicus* through the comparison of the mineral content in the forage and the body.

The research results showed that the average content of Se and Fe was significantly lower than the standard content, the content of Cu, Mn, Zn, Ca and Mg in the hair was significantly higher than that in whole blood. As *M. sifanicus* is a small ruminant, the results can be compared with those of other small ruminants. The content of

Table 4. The content of 8 mineral elements in the hair of *M. sifanicus*.

Elements	<i>Moschus sifanicus</i>		Local goats	
	($\bar{X} \pm SD$)	Range	($\bar{X} \pm SD$)	Range
Cu ($\mu\text{mol/L}$)	85.486 \pm 16.265	61.23~114.767	48.71 \pm 12.701	31.729~65.155
Mn ($\mu\text{mol/L}$)	39.749 \pm 21.239	11.721~77.532	*	*
Fe (mmol/L)	1.516 \pm 0.854	0.689~3.403	1.95 \pm 0.675	0.91~3.29
Zn ($\mu\text{mol/L}$)	1.851 \pm 27.60	1.735~2.109	1.114 \pm 0.42	0.356~1.894
Ca (mmol/L)	37.859 \pm 15.979	23.951~68.791	19.828 \pm 13.068	5.053~37.57
Mg (mmol/L)	18.577 \pm 4.629	11.11~22.568	6.444 \pm 4.155	1.776~14.43
Se ($\mu\text{mol/L}$)	0.003 \pm 0.004	0.001~0.016	0.003 \pm 0.001	0.002~0.003
Mo ($\mu\text{mol/L}$)	0.636 \pm 0.25	0.386~1.459	2.657 \pm 2.626	0.198~8.284

* Undetermined items.

Ca, Zn and Mg in the hair of *M. sifanicus* was significantly higher than that of goats and sheep, while Fe and Mo was significantly lower. The content of Fe in the whole blood of *M. sifanicus* was significantly higher than that of goats and sheep, while Ca and Mo were significantly lower (Liu et al., 1992).

The comparison of the mineral content of *M. sifanicus* with that of local healthy goats showed that there was interspecific difference in some elements. The difference was extremely significant in the Cu, Ca and Mg content. The comparison of the dispersion of elements distribution in *M. sifanicus* with that in goats showed that all elements distribution in the whole blood and hair of *M. sifanicus* was more centralizing. The other dispersions were small, which indicates that there was little variation in mineral content in whole blood and hairs of *M. sifanicus*.

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