Trop. J. Anim. Sci. 4 (1): 25 - 33 (2001)
ISSN: 1119-4308

DETERMINATION OF TRACE ELEMENTS IN THE HAIR OF HORSES

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Target Audience: Nutritionists, scientists, veterinarians, and horse owners and stable hands.

ABSTRACT

Hair samples from the mid sides of 18 horses were analysed for 7 trace elements—.cobalt (Co), copper (Cu), iron (Fe), lead (Pb), magnesium (Mg), silicon (Si) and zinc (Zn) using atomic absorption spectrophotometer (AAS) The resulting data were compared statistically according to the age and sex of the animals-6 adults (3 males and 3 females); 6 ponies (3 males, 3 females) and 6 foals (3 males, 3 females). Fe was found to be most abundant of the elements investigated. It had an overall mean of 270.78±69.78ppm. The others followed in this order: Zn (102.87±17.92 ppm); Cu, (4.85±2.08ppm); Mg, (0.18±0.09ppm); Co, (0.079±0.02ppm); Pb, (0.053±0.02ppm) and Si (0.033±0.01ppm).
Analyzing the data statistically with age and sex as variables revealed significant mean differences ($P<0.05$) among the 3 age groups (adult, pony, foal) and sexes (male and female). While some of the elements e.g. Cu increased in value from the young (foal) to the adult, others, e.g. zinc decreased in the same direction These findings are discussed with regard to their possible implications for the management of the horse

Keywords: Horse, hair, trace elements

INTRODUCTION

Horses are usually prize animals, which serve a variety of purposes in the domestic economy. They can be used as draught animals, recreational (pleasure) or even in high stakes competitive sports such as polo games and racing. This makes the animals very valuable and a lot of people are therefore involved in the horse industry – jockeys, the owners, the stakers, horse-hands, veterinarians, feed providers *et cetera*

For the above reasons a horse should always be in top shape for top

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performance. And for the veterinarian with equine practice, the health and welfare of the horse is of paramount importance. A similar statement can be made for the nutritionist, dietician and/ or feed miller engaged in compounding supplementary feed for the horse. He must not only know the nutritional value of the supplement he provides but somehow must liaise with other professionals in order to detect signs of deficiency or toxicity.

The pelage or coat of an animal being the first thing that catches an observer's eye usually gives a fair initial impression of the health or nutritional status of the animal. Infections and deficiency diseases usually affect the coat in a variety of ways such as unthriftiness, roughness, brittleness and alopecia (1,2,3). The trace element (TE) content of hair, according to reports, can give a fair indication of the nutritional or health status of the animal (4,5,6).

We recently embarked on a series of studies designed to elucidate the trace element distribution in the skin and hairs of animals found in this locality in order to provide a basic database on this parameter. This preliminary report on the occurrence of cobalt, copper, iron, magnesium, lead, silicon and zinc in the hair of the horse is part of this project.

MATERIALS AND METHODS

Hair samples were clipped off from the mid-sides of 18 horses in the stables of the Polo Club, Eleyele in Ibadan. The animals consisted of 6 adults (>18 months old), 6 ponies (8-18 months old) and 6 foals (< 8 months old). Each age group was equally divided between the sexes. The horses in these stables are usually kept semi-intensively i.e., in addition to pasture grazing in the paddocks; they are given supplemental concentrate feeding of grains. They are housed at night and are allowed unlimited access to water. The animals are routinely sprayed with acaricides and dewormed every 6 weeks.

The hair sample from each animal was put in a thoroughly cleansed plastic universal bottle with a cap. 0.5g of hair was weighed out from each sample using an analytical balance. This weighed sample was then put into a digestion tube containing 5ml of a digestion solution made up of 1 part perchloric acid and 3 parts nitric acid (specific gravity 1.70). All the samples, having been so treated, were put in a microwave oven for 3 minutes. The tubes were brought out and allowed to cool in a fume cupboard for 10 minutes. The content of each tube was then rinsed into a graduated cylinder with ultra-pure or de-ionized water and diluted to the 50ml mark with same water. After the resulting mixture had settled, 5ml of it were decanted into vials and used for the assay of the trace elements in an atomic absorption spectrophotometer (AAS).

RESULTS AND DISCUSSION

The mean values of the elements assayed in each sample for all the 3 age groups – adult, pony, foal (A, P, F) are shown in Table I. Statistical analysis of this data with age as the variable parameter is shown in Table 2 and Table 3 shows a further analysis based on sex relationships.

On the whole, iron (Fe) with an across- the- age- groups mean of 270.78±69.78 ppm (Table 1) was the most abundant of all the elements assayed. It was followed by zinc (Zn) with a mean of 102.87 ±17.92 p.p.m. The other elements were in this order. - copper (Cu, 4.85± 2.08ppm); magnesium (Mg, 0.18 ± 0.014ppm), cobalt (Co, 0.079±0.017ppm) lead (Pb, 0.053 ±0.02 ppm) and silicon (Si, 0.033 ±0.014 ppm).

On age relationships, analysis revealed the following (Table 1):

(i) Cobalt. No significant differences in the mean values of the 3 age groups even though the ponies (P) had the lowest and the foals (F) the highest means.

(ii) Copper: The mean value of this element increased from the foals to the adults. The difference in means between the adults (A) and the foals (F) was significant (p<0.05) but that between A & P and F &P were not.

(iii) Iron: There were significant differences in the means of A and P and A and F (P<0.05). The foals had the highest iron content in the hair while the adults had the lowest.

(iv) Lead: No significant age differences but the value of lead decreased from foal to the adult.

(v) Magnesium: Only the comparison between the Adults and Foals was significant (p<0.05). Adult had the highest while the foals had the least amount of magnesium.

(vi) Silicon: No significant differences on age basis.

(vii) Zinc: Even though the foals had the highest mean value it did not differ significantly from those of the other 2 age groups.

(viii) There was an inverse relationship between some of elements with respect to age. For instance for Cu and Zn, adults had the highest amount of Cu while the foals had the least but while the foals had the highest amount of Zn, the Adults had the least. Similarly, while the adults had the highest amount of magnesium and the lowest amount of iron the reverse was the situation with the foals.

When sex was introduced as a variable (Table 3) the relationships between male and female endowments in cobalt zinc, iron and silicon were not significantly different. However, those involving

Table 1: Mean values of Trace Elements in Horse Hair (in parts per million)

	TRACE ELEMENTS						
HORSES	Cobalt	Copper	Iron	Lead	Magnesium	Silicon	Zinc
ADULT	0.083±0.015	6.38±0.87**	209.76±42.15**	0.045±0.016	0.23±0.067**	0.033±0.016	95.54±11.70
FOAL	0.085±0.010	3.33±1.82**	326.83±34.51**	0.063±0.020	0.11±0.045**	0.035±0.016	111.50±13.19
PONY	0.070±0.021	4.82±2.23	275.73±69.13**	0.050±0.023	0.19±0.109	0.030±0.011	101.59±25.02
TOTAL	0.079±0.017	4.85±2.08	270.78±69.78	0.053±0.020	0.18±0.014	0.033±0.014	102.87±17.92

This table compares the mean ±std deviation of trace elements in the various age groups.

** Relationships are significant $p<0.05$.

magnesium, lead and copper were significant ($p < 0.05$). Across the age brackets no particular trends were discernible—some relationships were significantly different while others were not. In Table 2 is shown the significant age-based relationships across the age groups.

Table 2: Trace Element groups'comparison- paitwise (Based on Age/sex) (in parts per million)

	Cobalt X±S.D	Copper X±S.D	Iron X±S.D	Lead X±S.D	Magnesium X±S.D	Silicon X±S.D	Zinc X±S.D
AF	0.0933±0.0058	6.343±0.378	178.53±27.47	0.047±0.023	0.180±0.016	0.020±0.010	87.10±9.65
AM	0.0733±0.0153	6.417±1.325	240.99±45.98	0.043±0.011	0.290±0.044	0.047±0.006	103.97±6.94
FF	0.0900±0.0100	4.917±0.860	318.80±28.99	0.080±0.010	0.102±0.026	0.080±0.010	106.14±12.22
FM	0.0800±0.0100	1.760±0.221	334.86±44.08	0.047±0.006	0.119±0.064	0.050±0.000	116.85±14.13
PF	0.0867±0.0153	6.530±1.779	337.18±32.72	0.067±0.021	0.278±0.044	0.023±0.006	88.13±12.75
PM	0.0533±0.058	3.113±0.891	219.29±36.33	0.033±0.006	0.106±0.075	0.037±0.012	115.05±29.30
TOTAL	0.0794±0.0167	4.847±2.080	270.78±69.78	0.053±0.020	0.179±0.091	0.328±0.014	102.87±17.92

This table shows the relationships that are significant ($p<0.05$) across the age groups and sexes.

According to Underwood (7) and Suttle (8) trace elements are required in small quantities for the normal functioning of an organism. But, although over 16 such elements have been identified (9), recent reviews (10,11) tend to emphasize that only about 10 are really essential for human health. There is even some confusion on the classification of such elements as iron, magnesium and fluorine as either trace or macro-elements (10,11).

'We have in this study demonstrated the presence of cobalt, copper, iron, lead, magnesium, silicon and zinc in the body hair of the horse. Although the presence of some of these elements had been reported in the hair of other species (5, 12, 13) there has been no previous report, to our knowledge, of their occurrence in the hair of horses.

Iron is one of the most abundant elements on earth (14) but whether this will account for its overwhelming presence in the hair of the horse is difficult to tell. It is essential for the synthesis of haemoglobin, myoglobin and the cytochromes. About 5mg/L of iron is lost through sweating in horses but it is thought (3) that the 50-70mg/kg daily requirement can easily be met from adequate provision of quality diets which are naturally rich in iron. We cannot from this study make a definitive inference on the nature or form of the iron in the hair but we postulate that its origin must be dietary as a relationship between diet and the iron content of hair had been demonstrated elsewhere (3,4,15). We can also affirm that it is not a contaminant as the grooming and the extensive cleansing undertaken in the study would have reduced this to the barest minimum. Because iron is lost through sweat (3) excessive production of sweat or lack of it will affect iron balance in the animal. In the horse, the coat becomes rough implying possible mobilization of the iron in the hair.

The finding that some of the mineral elements interacted inversely with one another in animal tissues is confirmed by previous reports (3,5). For instance zinc and copper had been shown to interfere with each other a fact that is in agreement with their reciprocal relationship as found in the adults and foals in this study. Both zinc and copper have been implicated in the aetiology of developmental orthopaedic disease (DOD) of horses (3). Although the mechanism or pathogenesis of this disease is unclear, both zinc and copper have to do with metalloenzymes such as lysyl-oxidase, that are responsible for cross-linking of collagen and the stability of connective tissue. They are also concerned with wound healing (16) and would therefore be very essential especially in highly active animals such as horses, which could be prone to injuries.

The low amount of magnesium found in the hair of horses is rather surprising. While this may qualify the classification of magnesium as a trace element in the horse it is in sharp contrast to observations in small ruminants hair where the large quantity of magnesium encountered led the investigators (12) to opine that magnesium may not be a trace element in small ruminants. Magnesium reportedly (17) is the fourth-most abundant cation and is principally distributed to the skeleton and extracellular component (18). In the horse it is probably very important for muscle exertion (19) and deficiency may lead to limb deformities in foals (3).

Cobalt, lead and silicon were present in very minute quantities. Cobalt is mainly required for intestinal biosynthesis of vitamin B12. It should therefore be more needed in breeding animals and growing youngsters This hypothesis was proved right in this study only in relation to the foals (Table 1). However, as Table 3 shows, the females were less endowed than the males although the difference was not significant .even though the breeding status of the females sampled was not particularly attended to at time of sampling.

As shown in Table 3 the females had significantly more lead in the hair than the males. This does not agree with observations of Meng (5) who found more lead in male than in female hair in human subjects in the Shanxi province of North China. However, the inverse relationship between lead and zinc observed in this study (see Table 3) is in agreement with Meng's findings in the study cited above. Lead is toxic to the animal. This toxicity manifested by, among other features, a rough coat may account for the

Table 3: Mean values (in parts per million) (Between males and Females) of Trace Elements in Horse Hair ±±

		No. of Cases	Mean ±± S.D.	S. Error	Calculated t	Degree of Freedom	2-Tail Prob	Not Sign	Sign
PPM/Co	Male	9	0.0756±±0.019	0.006	0.99	16	0.336	P>0.05	
	Female	9	0.0833±±0.014	0.005					
PPM/Mg	Male	9	0.1349±±0.060	0.020	2.32	16	0.034		P<0.05
	Female	9	0.2234±±0.097	0.032					
PPM/Pb	Male	9	0.0456±±0.011	0.004	2.27	16	0.037		P<0.05
	Female	9	0.0633±±0.021	0.007					
PPm/Si	Male	9	0.0356±±0.015	0.005	0.81	16	0.432	P>0.05	
	Female	9	0.030±±0.014	0.005					
PPM/Fe	Male	9	244.2267±±77.051	25.684	1.70	16	0.108	P>0.05	
	Female	9	297.3233±±53.147						
PPM/Cu	Male	9	3.7389±±1.422	0.700	2.62		0.019		P>0.05
	Female	9	5.9544+1.422	0.474	2.62		0.019		
PPM/Zn	Male	9	106.2789+22.234	7.411	0.81	16	0.432		P<0.05
	Female	9	99.4144+12.622	4.02					

very small amount of lead observed in this study. As Tsukuba and Sugahara (7) pointed out improved diet reduces the lead content of hair in humans. This could also be the case in horses.

Silicon is about the most abundant cation on earth but the minute quantities seen in the horse hair is probably a reflection of the very trace amounts of the element required by the horse for its daily metabolism.

Our findings in this study of differential endowments of trace elements between the sexes are confirmed by previous reports (3,5). This may not be unconnected with a differential dietary intake based on physiological state (3).

CONCLUSION

In conclusion, this study has demonstrated the presence of the seven trace elements assayed in the hair of the horse. It has also shown that the elements are present in different quantities in the different sexes and age-groups. In this regard, the hair of the horse is not different from the hair of other mammals including man. We, however, do not know in what state these elements occur in the horse's hair. The nature of their occurrence, that is, whether they are part of enzyme systems or structural components of the hair, is the subject of further investigation.

ACKNOWLEDGEMENT

The authors appreciate greatly the secretarial services of Chief M. A Ajayi of the department of Veterinary Anatomy, University of Ibadan

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