

Effect of haemoglobin type on the concentration of plasma copper in Merino, Dohne Merino and SA Mutton Merino ewes

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The effect of haemoglobin type (AA, AB, BB) on the concentration of plasma copper of dry non-pregnant Merino, Dohne Merino and SA Mutton Merino ewes, kept under the same grazing conditions, was studied. Merino ewes tended to have the highest concentrations of plasma copper of the three breeds. Merino ewes of haemoglobin type BB had the highest concentration of plasma copper within this breed. No tendency regarding plasma copper and haemoglobin type were evident within the other two breeds.

Die invloed van hemoglobientipe (AA, AB, BB) op die plasmakoperkonsentrasie van droë, nie-dragtige Merino-, Dohne Merino- en SA Vleismerino-ooie wat onder dieselfde voedingstoestand aangehou is, is ondersoek. Plasmakoperkonsentrasies van Merino-ooie het die hoogste van die drie rasse geneig. Merino-ooie van hemoglobientipe BB het die hoogste plasmakoperkonsentrasies binne die ras gehad. Geen definitiewe verwantskap tussen hemoglobientipe en plasmakoperkonsentrasies is by die ander twee rasse gevind nie.

Keywords: Haemoglobin type, plasma copper, sheep breeds.

Genetic relationships, including breed differences, in the copper metabolism of most of the British sheep breeds, are well documented. Differences in the copper metabolism as well as the susceptibility of lambs for enzoötic ataxia between breeds have been identified (Wiener, 1966). These breed differences are important when copper is supplemented. Wiener & McLoed (1970) found significant breed differences in mortality following copper supplementation of sheep by means of injectable copper complexes. Within the same breed, groups with high and low concentrations of blood copper were identified (Wiener, 1979). Haemoglobin type was also found to have an influence on blood copper concentrations.

Sheep of haemoglobin type BB (genotype Hb^{bb}) had the highest concentration of blood copper followed by sheep of haemoglobin type AB (genotype Hb^{ab}) and haemoglobin type AA (genotype Hb^{aa}) (Wiener, Hall & Hayter, 1973).

Certain sheep breeds such as the Dormer, Dorper, Dohne Merino and, to some extent, the SA Mutton Merino were developed in South Africa. In the case of the SA Mutton Merino, attempts were made to breed bigger sheep with better mutton and wool characteristics as its predecessor, the German Merino. To date, the trace mineral needs, differences in the metabolism and the sensitivity of these breeds to trace element supplementation (toxicity) are still ill-defined. It was the objective of this study to determine whether breed and haemoglobin type had any influence on the concentrations of plasma copper of Merino, Dohne Merino and SA Mutton Merino ewes in an attempt to clarify possible breed differences which are important in any trace element supplementation programme.

Two- to five-year-old Merino (78), Dohne Merino (97) and SA Mutton Merino (104) ewes were used. Prior to blood sampling, the ewes were kept under identical feeding and grazing conditions consisting of kikuyu and lucerne pastures. They were run as a single flock for a period of approximately four months. During August 1985, when all the ewes were dry and non-pregnant, two blood samples were taken simultaneously from the jugular vein of each ewe with 18G needles in heparinized vacuum tubes (Vac U Test). One blood sample was centrifuged at 3000 r.p.m. and the plasma was removed and stored at 4°C. The concentrations of plasma copper were determined the following day by diluting plasma 1:5 with distilled deionized water after which it was aspirated directly into an atomic absorption spectrophotometer (Phillips Pye–Unicam Model SP 9) (Van Niekerk, 1985). The remaining blood sample was air-mailed at the day of sampling to Onderstepoort (RSA) for haemoglobin typing. Haemoglobin typing was done by means of gel electrophoresis (Van Niekerk, 1985).

Standard procedures for the analysis of a 3 × 3 factorial design (with one missing subclass) were followed, using least-squares procedures to allow for uneven subclasses (Harvey, 1977). Differences between least-squares means were tested by *t*-test procedures (Snedecor & Cochran, 1980).

The distribution of haemoglobin type between different age groups of the three breeds is shown in Table 1.

The frequency of haemoglobin type AA was very low in the Merino (0,18) and Dohne Merino (0,05) breeds, with none found in the SA Mutton Merino herd. The distribution of haemoglobin types AB and BB also varied considerably between the remaining ewes of the three breeds. Nevertheless, this distribution of haemoglobin type within breeds should not be regarded as typical for these breeds.

The mean concentration of plasma copper of the ewes with different haemoglobin types is shown in Table 2.

Table 1 Distribution of haemoglobin type between different age groups of the three breeds

Age (years)	Haemoglobin type	Dohne Merino			SA
		Merino	Merino	Merino	Mutton Merino
5	AA	1	1	–	–
	AB	5	6	5	5
	BB	5	14	10	10
4	AA	4	–	–	–
	AB	7	9	5	5
	BB	5	13	5	5
3	AA	4	2	–	–
	AB	15	15	4	4
	BB	9	15	34	34
2	AA	5	2	–	–
	AB	13	12	8	8
	BB	5	9	32	32
Frequency of total	AA	0,18	0,05	–	–
	AB	0,51	0,43	0,21	0,21
	BB	0,31	0,52	0,79	0,79

Table 2 A comparison of the mean (\pm SD) concentrations (μ g/dl) of plasma copper between haemoglobin type within breed for three sheep breeds

Breed	Haemoglobin type		
	AA	AB	BB
Merino	116 ^a \pm 9 n = 14	146 ^b \pm 5 n = 40	173 ^c \pm 7 n = 24
Dohne Merino	125 \pm 15 n = 5	129 \pm 5 n = 42	130 \pm 5 n = 50
SA Mutton Merino	– n = 0	130 \pm 7 n = 22	149 \pm 4 n = 82

^{a,b,c} Values in the same row with different headings differ significantly ($P \leq 0,05$).

n = Number of ewes.

The mean concentration of plasma copper in Merino ewes of haemoglobin type BB was higher ($P \leq 0,05$) than that of type AB, with both these groups having higher concentrations of plasma copper than ewes of haemoglobin type AA. In the Dohne Merino there was virtually no difference in the concentration of plasma copper between ewes of different haemoglobin types. Although the mean concentration of plasma copper between haemoglobin types AB and BB in the SA Mutton Merino did not differ significantly, the mean concentration of type BB tended higher. With regard to Merino and SA Mutton Merino ewes, present findings agree with that of Wiener *et al.* (1973), suggesting that sheep of haemoglobin type BB have higher concentrations of plasma copper than sheep of the other haemoglobin types.

Differences in copper metabolism between some of the British sheep breeds are known from the literature.

Wiener, Suttle, Field, Herbert & Woolliams (1978) indicated that sheep breeds differ in their ability to absorb copper from the digestive tract. Lambs from the North Ronaldsay breed absorbed copper more efficiently from the digestive tract than lambs of the Scottish Blackface and Welsh Mountain breeds. Herbert, Wiener & Field (1978) have also shown that sheep breeds differ in their ability to retain copper in their livers. It seems possible that genetic factors, such as haemoglobin type AA, which might influence the copper metabolism in sheep can be totally excluded from a specific herd with selection. It is possible that sheep with haemoglobin type AA (which might possibly result in lower plasma copper concentrations) may also have a lower production and reproduction rate in copper deficient and marginal copper deficient areas like the Western Cape and coastal areas. With selection over many years these poor performers, which could probably fall in the AA group, were culled. This may be a reason why there is only a small percentage of ewes of haemoglobin type AA left in the Merino and Dohne Merino and none in the SA Mutton Merino in these herds. This preliminary findings should be investigated further because it is known that copper is very important for wool production as well as reproduction. Since the Merino tended to have higher concentrations of plasma copper than the other two breeds, it might be an indication of a higher nutritional need for copper.

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References

- HARVEY, W.R., 1977. User's guide for LSML-76. Mixed model least-squares and maximum likelihood computer program. Ohio State University, Columbia, USA.
- HERBERT, J.G., WIENER, G. & FIELD, A.C., 1978. The effect of breed and of dried seaweed meal in the diet on the levels of copper in the liver, kidney and plasma of sheep fed on a high-copper diet. *Anim. Prod.* 26, 193.
- SNEDECOR, G.W. & COCHRAN, W.G., 1980. Statistical methods (7th edn.). Iowa State University Press, Ames, Iowa, USA.
- VAN NIEKERK, F.E., 1985. Die effek van sekere spoorelemente op die vrugbaarheid van SA Vleismerino-oie. MSc.-verhandeling, Universiteit van Stellenbosch, Stellenbosch.
- WIENER, G., 1966. Genetic and other factors in the occurrence of swayback in sheep. *J. Comp. Path.* 76, 435.
- WIENER, G., 1979. Review of genetic aspects of mineral metabolism with particular reference to copper in sheep. *Livest. Prod. Sci.* 6, 223.
- WIENER, G., HALL, J.G. & HAYTER, S., 1973. An association between the concentration of copper in whole blood and haemoglobin type in sheep. *Anim. Prod.* 17, 1.
- WIENER, G. & McLOED, J., 1970. Breed bodyweight and age as factors in the mortality rate of sheep following copper injection. *Veterinary Record* 86, 740.
- WIENER, G., SUTTLE, N.F., FIELD, A.C., HERBERT, J.G. & WOOLLIAMS, J.A., 1978. Breed differences in copper metabolism in sheep. *J. Agric. Sci.* 91, 433.