Concentrations of blood minerals and metabolites, as well as production characteristics of Angora goats in the Southern Cape

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Concentrations of plasma copper and zinc and blood selenium in Angora goats and Merino sheep were determined monthly over a one-year period, and were compared. Results indicate that Angora goats have higher concentrations of plasma copper and lower concentrations of blood selenium ($P < 0.05$) than Merino sheep kept under the same feeding conditions. Blood samples collected from Angora kids, 12-month-old goats and adult goats showed that the plasma phosphorus, magnesium, calcium, potassium, sodium, zinc, total protein, albumin and globulin concentrations were within expected ranges normally found in sheep.

Plasmakoper-, plasmazink- en bloedseleniumkonzentrasies van Angorabokke en Merinoskape is maandeliks, oor 'n jaarperiode, bepaal en vergelyk. Resultate toon dat Angorabokke hoër plasmakoper- en laer ($P < 0.05$) bloedseleniumkonzentrasies as Merinoskape, wat onder dieselfde voedingtoestande aangehou word, handhaaf. Die bloedmonsters van Angoralammers, 12- maande-oue Angorabokke en volwasse bokke toon dat die plasmaplasmafosfaat-, magnesium-, kalsium-, kalium-, natrium-, sink-, totale proteïen-, albumien- en globulienkonzentrasies binne die normale grense vir skape varieer.

Keywords: Angora goats, blood metabolites, blood minerals, Merino sheep.

Nutrient requirements for sheep are used to estimate requirements for Angora goats. This practice, however, does not take any possible species differences into account. Kritzinger (1988) reported that the syndrome known as ‘rugsiekte’, which affects young Angora goat rams fed on a commercial lucerne-based diet for several months, was relieved by treatment with an injectable zinc solution. This commercial diet is, however, fed to sheep without resulting in similar symptoms. Several cases of selenium deficiency were recently reported in Angora goats, grazing with sheep of various breeds on irrigated pastures – the latter showing no signs of a selenium deficiency (F.E. van Niekerk, 1988; unpublished results). Since these differences were not observed under controlled conditions, the present study was undertaken to determine whether blood trace-element and metabolite concentrations in Merino sheep differed from those of Angora goats kept under similar feeding conditions.

Two experiments were conducted at Tygerhoek, an experimental farm belonging to the Department of Agricultural Development, situated near Riviersonderend in the Southern Cape. In the first experiment, blood samples (20 ml) were collected monthly over a one-year period from 10 Merino ewes and 10 Angora wethers for the determination of concentrations of plasma copper and zinc and blood selenium. The same animals were used throughout this trial and were ca. 10—12 months of age at the time of first sampling. The sheep and goats were run as separate flocks on the farm, although both groups grazed similar lucerne-based, dryland pastures on a predominantly Glenrosa soil-type, six months prior to first sampling.

In the second experiment, the commercial Angora goat flock kept at Tygerhoek was used. Angora goats used in both experiments were kept as a single flock. During September 1987, after lambing, 20-ml blood samples were taken from all the goats comprising 126 animals, including the 10 wethers used in the first part of this study. Samples of 10 ml blood were placed in a container (<10°C) and transported to the laboratory on the same day. These samples were stored at 4°C overnight and analysed for glutathione peroxidase (GSH–px) activity (Langlands, Donald, Bowles & Smith, 1980) on the following day. Blood selenium concentrations were determined using the method of Koh & Benson (1983). The remaining 10-ml blood samples were centrifuged within 3 h after collection, and the plasma was removed for analyses of phosphorus, calcium, magnesium, copper and zinc according to the methods used by Van Niekerk & Van Niekerk (1989). Plasma potassium, and sodium, total plasma protein, albumin and globulin were determined as described by Van Niekerk, Van Niekerk & Morgenthal (1988).

The monthly copper, zinc and selenium concentrations determined in Experiment I for the Merino sheep and Angora goats were compared by pairwise $t$-test procedures (Snedecor & Cochran, 1980), and are given in Table 1. Mean reproduction rates of the Angora does and live mass and fleece mass parameters for the kids were calculated for the lambing seasons from 1986 to 1988. Differences between Angora goats of different age groups were investigated by standard one-way analysis of variance procedures, using the P1V program of the BMDP statistical packet (Engelman, 1981). Differences between treatment means were tested by pairwise $t$-test procedures. Concentrations of blood selenium values were regressed on GSH–px activity using the PSR polynomial regression program of the BMDP statistical packet (Engelman, 1981).

Table 1 shows that neither of the two species suffered from either a copper, zinc or selenium deficiency, since concentrations of plasma copper and zinc and of blood selenium less than 60 µg/dl and 50 µg/ml, respectively, which are regarded as deficient (Underwood, 1977), were not found.
Table 1 Comparison of the mean (± SD) concentrations of plasma copper and zinc as well as blood selenium between Merino sheep (n = 10) and Angora goats (n = 10) over a one-year period

<table>
<thead>
<tr>
<th>Date</th>
<th>Copper (µg/dl)</th>
<th>Zinc (µg/dl)</th>
<th>Selenium (ng/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Merino</td>
<td>Angora</td>
<td>Merino</td>
</tr>
<tr>
<td>Feb. 1987</td>
<td>63 ± 12</td>
<td>98 ± 10</td>
<td>66 ± 4</td>
</tr>
<tr>
<td>March 1987</td>
<td>90 ± 8</td>
<td>113 ± 16</td>
<td>68 ± 9</td>
</tr>
<tr>
<td>April 1987</td>
<td>84 ± 11</td>
<td>137 ± 20</td>
<td>69 ± 8</td>
</tr>
<tr>
<td>May 1987</td>
<td>88 ± 10</td>
<td>117 ± 10</td>
<td>78 ± 12</td>
</tr>
<tr>
<td>June 1987</td>
<td>88 ± 6</td>
<td>126 ± 15</td>
<td>73 ± 5</td>
</tr>
<tr>
<td>July 1987</td>
<td>86 ± 11</td>
<td>112 ± 8</td>
<td>82 ± 11</td>
</tr>
<tr>
<td>Aug. 1987</td>
<td>83 ± 11</td>
<td>105 ± 13</td>
<td>70 ± 9</td>
</tr>
<tr>
<td>Sept. 1987</td>
<td>92 ± 12</td>
<td>95 ± 16</td>
<td>114 ± 11</td>
</tr>
<tr>
<td>Oct. 1987</td>
<td>84 ± 7</td>
<td>101 ± 15</td>
<td>76 ± 5</td>
</tr>
<tr>
<td>Nov. 1987</td>
<td>86 ± 7</td>
<td>115 ± 11</td>
<td>79 ± 6</td>
</tr>
<tr>
<td>Dec. 1987</td>
<td>103 ± 10</td>
<td>134 ± 14</td>
<td>76 ± 10</td>
</tr>
<tr>
<td>Jan. 1988</td>
<td>94 ± 14</td>
<td>120 ± 69</td>
<td>69 ± 11</td>
</tr>
</tbody>
</table>

a,b Denote significant (P < 0.05) differences between species.

There was no distinct seasonal pattern for either the concentrations of plasma copper or zinc (Table 1). This is normal when the copper and zinc supply of animals is adequate. From these results, it seems that the Angora goats maintain higher (P < 0.05) concentrations of plasma copper than Merino sheep, when kept under the conditions described. No noteworthy differences in concentrations of plasma zinc were found. Definite seasonal differences were, however, found in concentrations of blood selenium, with the highest concentrations recorded during late summer/early autumn and the lowest during spring. Over the entire experimental period, the concentrations of blood selenium of the Angora goats were lower (P < 0.05) than those of the Merino sheep. This finding was confirmed on several other farms, where sheep and Angora goats grazed together (F.E. van Niekerk, 1988; unpublished results).

Production parameters for Angora goats at Tygerhoek are presented in Table 2. The reproduction rate of the Angora does was generally higher than the conception (84.5%), fecundity (109.6%) and lambing (92.7%) rates of South African Angora goats as reported by Terblanche (1988). Fleece mass at 6 months of age was somewhat higher than the value of 1.06 kg reported by Terblanche (1988). Fleece mass at 12 months was also substantially higher than masses reported for Grootfontein Angora goats by Delport (1986). Livemass at 13 months was between 52.8 and 78.3% higher than the corresponding 12-month masses reported by Delport (1986). From these results, it is evident that Angoras at Tygerhoek were kept under favourable nutritional conditions and that reduced production, owing to a severe mineral deficiency, is unlikely on this particular farm.

Concentrations of plasma phosphorus, magnesium and calcium of Angora goats (Table 3) were similar to those previously described for sheep (Van Niekerk, Van Niekerk, Heine & Coetzee, 1990). Similar to the situation in Angora kids and adult does (Table 3), lambs showed higher (P < 0.01) concentrations of plasma phosphate and calcium than ewes.

Concentrations of potassium and sodium in plasma were similar to concentrations previously reported for sheep (Swenson, 1977). It has been shown that lambs may have low concentrations of plasma copper at birth (Van Niekerk, Van Niekerk, Heine & Coetzee, 1990), similar to those described in Table 3. Van Niekerk et al. (1990) found that concentrations of plasma zinc in newborn lambs were approximately 40% higher than those of ewes, but that these declined to the level found in adult ewes within 14 days.
were derived: reaction time (Table 3) the following regression equations were derived:

\[
\text{Blood selenium concentration} = \text{GSH-px activity}
\]

Many laboratories use the GSH-px spot test to identify selenium responsive disorders in animals. While a GSH-px reaction time of less than 4 min is considered to be normal, values in excess of 10 min are usually taken to be indicative of a selenium deficiency in sheep (E.W.P. Heine, 1988; unpublished results). By comparing the concentration of blood selenium and the GSH-px reaction time (Table 3) the following regression equations were derived:

\[
\text{Blood selenium concentration} = \text{GSH-px activity}
\]

All regression coefficients were significant \((P \leq 0.01)\), indicating a definite relationship between blood selenium and GSH-px reaction time. The accuracy of the spot test would, however, appear to be limited in young and adult goats, reflected by correlation coefficients of \(<0.50\). GSH-px activity assayed by means of the spot test does not normally correlate as closely with blood selenium content as that measured by spectrophotometric assay (Langlands, Donald, Bowles & Smith, 1980).

Most GSH-px in blood is located in the erythrocyte and GSH-px activity can be expressed relative to the amount of haemoglobin (Langlands et al., 1980). Whereas mean haemoglobin (Hb) concentration did not differ significantly between the three age groups (Table 2), that of selenium, however, differed significantly \((P \leq 0.01)\) (see Table 3). It appears that the haemoglobin of Angora kids contains less selenium per unit Hb than those of the other two age groups. The 12-month-old animals appeared to have the highest selenium content per unit Hb.

Blood selenium concentrations were reported for sheep bearing both high (GSH\(^b\)) and low (GSH\(^b\)) genes (Tucker & Kilgour, 1970). Agar, Roberts & Evans (1972) postulated that sheep with Hb type-BB have a lower erythrocyte GSH-px value than animals with Hb type-AB. The effect of these genetic differences must be considered in future studies. When considering any genetic factors which might influence mineral metabolism in Angora goats, it should be remembered that Osterhoff, Schmid & Schoeman (1987) found that Angora goats apparently possessed only Hb type-AA. Results for other goat breeds that were studied were similar (Osterhoff et al., 1987), and one can therefore assume that Hb type-AA is dominant in goats. Total plasma protein, albumin and globulin concentrations of Angora goats were within the normal ranges described for sheep (Swenson, 1977).

The variation in plasma phosphorus, magnesium, calcium, potassium, sodium, zinc, total plasma protein, albumin and globulin concentration of Angora goats lies within normal ranges for sheep. These differences may possibly be related to genetic differences between the two species. Further studies on the differences in mineral metabolism between Angora goats and sheep are envisaged.

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