Hepatic vitamin A concentrations in sheep in north-western Queensland

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Sheep areas in north-western Queensland lie between the 10 inch (254 mm) and 20 inch (508 mm) isohyets. Effective rainfall occurs mainly in summer; winter rain, when it occurs, does not generally influence further pasture growth. In a typical year sheep graze for long periods on dry, mature pasture and droughts occur one year in four (Anon. 1966).

Productivity, including lamb marking percentage, is low in this environment. The average lamb marking percentage was 34 to 42 per cent from 1942-54 (Moule 1956) and 30 to 50 per cent (mean 42 per cent) 1954-68†. These figures can be compared with values of 58-66 per cent in south-eastern Queensland in 1942-54 (Moule 1956).

In times of drought, pastures in this region undoubtedly contain little β-carotene, and since a deficiency of vitamin A has adverse effects on reproduction (Moore 1957), the possibility existed that such a deficiency was contributing to the low lamb marking percentages. We examined this possibility by conducting a survey of the vitamin A concentration in the livers of both young and adult sheep.

Materials and methods

Environment

Liver samples were obtained from sheep at the Toorak Sheep Field Research Station 56 km south of Julia Creek, Queensland. Situated at a latitude of 21°S in the shire of McKinlay, the station comprises 14,600 ha of open Mitchell grass downs country. It is typical of much of the north-western pastoral zone of the State embracing the neighbouring shires of Cloncurry, Richmond, Flinders, Winton, and Boulia, an area supporting about 5 million sheep on 550 properties. Most sheep in this zone are within a radius of about 160 km of this station. Although Mitchell grasses (*Astrebla* spp.) dominate the perennial pasture, sheep preferentially graze annual pasture species, but the former must be relied on to support stock when alternative grazing is not available (Weston and Moir 1969).

The annual rainfall averages about 430 mm. Monthly average maximum screen temperatures exceed 35°C for 4-6 months each summer. Daily maxima commonly exceed 38°C consecutively for periods of 2-3 weeks. Winter minima average about 7°C, but may be much lower during periods of strong westerly to south-westerly winds.

Animals and treatments

The results were obtained from two classes of wether sheep, both of Medium Peppin origin. One group of 123 comprised sheep slaughtered to provide fresh meat and will be referred to as adult sheep. These sheep originated from various flocks and ranged in age from approximately one to five years. Two liver samples were submitted for vitamin A analysis at about two-weekly intervals from October 1964 to October 1967.

The second group comprised 240 weaner wether sheep selected from the April to May lamb drop in 1967 and will be referred to as young sheep. These were weaned in August and randomly subdivided into groups of 20 animals each. The groups were randomly assigned to slaughter periods and grazed as part of a large flock at a stocking rate of about 1 sheep to 1.6 ha. From August 1967 to March 1968 groups of 20 were slaughtered at monthly intervals. From April to July 1968 the number slaughtered each month was reduced by random selection to 10 sheep. The age at slaughter ranged from 15 to 64 weeks. Livers obtained at slaughter were analysed for vitamin A concentration.

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† These figures were calculated from official statistics of the state of Queensland.

At weaning in August 1967, 19 dams of the young sheep were slaughtered and their livers collected for vitamin A analysis.

Vitamin A analyses

Approximately 20 g of liver from each sheep were weighed, placed in a 100 ml glass jar, covered with 10 per cent aqueous potassium hydroxide and submitted to the laboratory for vitamin A analysis, as described by Gartner and Ryley (1956).

Results

Adult sheep

The mean hepatic concentration of vitamin A in 123 sheep was 260.3 ± SD 128.3 μg/g with a range of 48 to 645 μg/g. The individual values are plotted in figure 1 and show neither a consistent relationship with the amount of rainfall nor an overall trend with season or time.

Young sheep

Livers from 199 young sheep were analysed over the period August 1967 to August 1968. Although there was an overall increase in concentration with age (table 1), there was a decrease during the October-January period when the lowest individual values were recorded. There was no correlation between liver vitamin A concentration and body weight at any period.

Liver samples of some of the dams were analysed at weaning when the lambs were 15 weeks old. The mean liver vitamin A concentration of 19 ewes was 280 ± SD 129.8 μg/g.

Discussion

The mean hepatic reserve of vitamin A in the adult sheep (260.3 ± SD 128.3 μg/g) was slightly higher than the mean value of approximately 200 μg/g quoted for sheep by Moore (1957), but lower than the mean values of 610 ± SD 376 μg/g (Gartner and Anson 1966) and 710 ± SE 113 μg/g and 617 ± SE 123 μg/g (Gartner and Anson 1969) found in sheep from south-western Queensland. The high values encountered in the latter sheep were most likely due to the relatively high β-carotene content of mulga leaves, which are the principal reserve drought fodder in much of south-western Queensland and which were being grazed at the time.

The lowest individual vitamin A level of 48 μg/g in the adult sheep is considered adequate from the clinical point of view based on the observation that nyctalopia which is the first clinical sign of avitaminosis A noted in sheep (Eveleth, Bolin and Goldsby 1949),

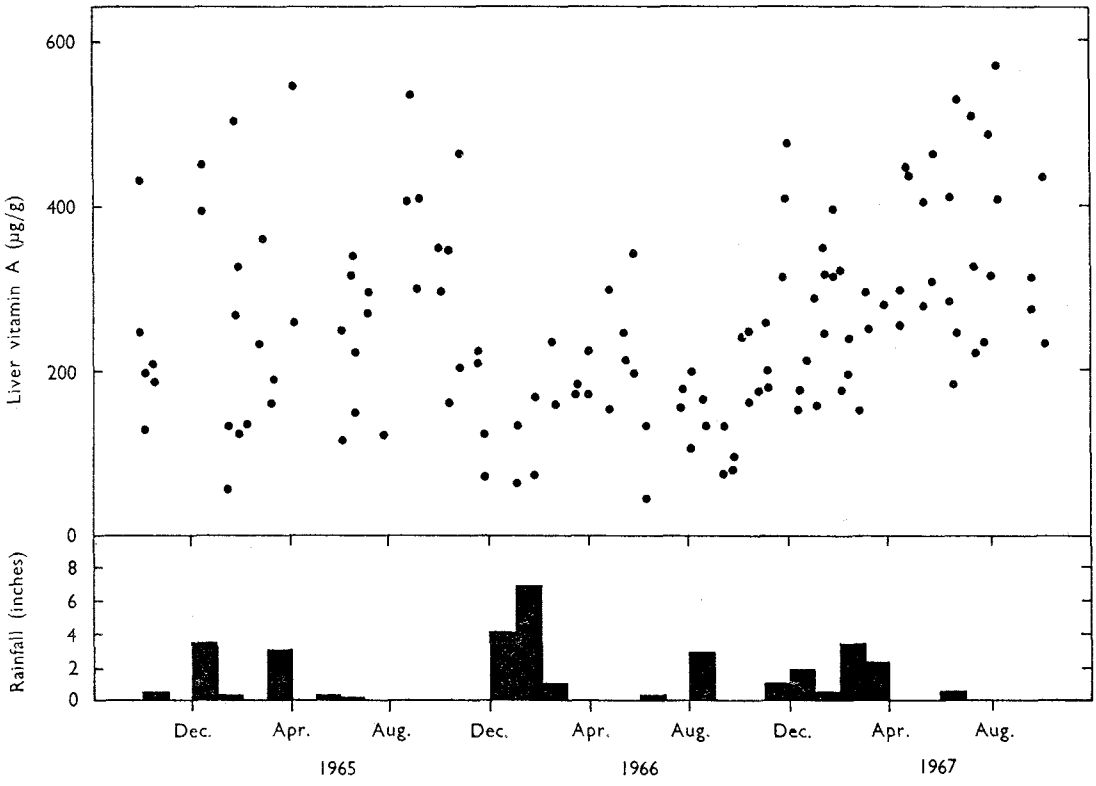

Figure 1—Hepatic concentration of vitamin A in adult sheep in north-western Queensland from October 1964 to October 1967, together with rainfall data.

TABLE 1

Group mean hepatic vitamin A concentrations and body weights of weaner sheep grazing extensively on Mitchell grass downs in north-western Queensland.

Date of slaughter	No. of sheep	Age	Liver vitamin A Mean ± S.D.	Range	Body weight mean ± S.D.	Rainfall†
		weeks	*μg/g*		*kg*	*mm*
1967						
Aug. 15	20	15	80.3 ± 35.4	31–170	14.9 ± 3.5	0
Sept. 28	19	21	90.4 ± 41.7	25–163	14.9 ± 3.4	0
Oct. 24	20	25	59.6 ± 30.1	9–130	18.4 ± 2.5	0
Nov. 21	17	29	40.4 ± 41.3	4–167	17.3 ± 2.7	4.1
Dec. 19	20	33	42.8 ± 32.2	10–120	18.6 ± 3.0	27.2
1968						
Jan. 22	19	38	84.8 ± 28.4	30–131	16.8 ± 2.0	39.1
Feb. 22	19	42	121.8 ± 53.2	40–205	15.7 ± 1.9	53.8
Mar. 18	17	46	177.7 ± 50.6	104–276	23.2 ± 3.3	6.4
Apr. 16	8	49	154.1 ± 35.2	105–210	24.9 ± 3.3	35.8
May 20	10	54	253.1 ± 53.9	177–326	26.0 ± 4.1	100.1
June 11	10	57	205.2 ± 77.8	141–403	27.6 ± 2.4	0
July 2	10	60	265.0 ± 97.1	126–408	29.3 ± 3.8	736.6
Aug. 1	10	64	242.9 ± 58.1	156–345	33.1 ± 3.7	0

† The sheep were born in April-May 1967. Rainfall: April (0), May (0), June (12.7 mm), July (0).

is not apparent until hepatic reserves fall to 4 μg/g or less (Pierce 1945).

There was no obvious decline in the vitamin A reserves of the adult sheep associated with extended periods (up to five months) of no rainfall. This is in keeping with previous findings with sheep that the rate of utilization of hepatic vitamin A is low under drought feeding conditions (Guilbert, Miller and Hughes 1937; Schmidt 1941; Eveleth, Bolin and Goldsby 1949; Sapsford 1951; Pierce 1954; Campbell 1956). This applies also to pregnant and lactating ewes (Gartner and Morris, unpublished data).

The adult sheep used in the survey were possibly a biased selection of the groups from which they were drawn in that, being selected for human consumption, they would be those in the best body condition of those available. The young, recently weaned animals, however, were from a class of sheep in which either marginal or deficient levels of vitamin A could be expected.

Individual levels of vitamin A in most of the young sheep were lower than in adult sheep, which is to be expected as lambs are born with low reserves of this vitamin (Moore 1957). The lowest levels of 4 μg/g liver were recorded in two 29-week-old wethers at a period preceded by only 13 mm of rain over seven months. However, rain was recorded in each of the following seven months and both the minimum and the mean levels increased to a stage where at 60 weeks of age the mean level of 265 μg/g was equivalent to the value found in the adult sheep.

The decrease in body weight in February followed by a marked increase in March has been observed in two other groups of young sheep at the Toorak Sheep Field Research Station. A possible explanation for this effect is loss of grazing time during the period of 12 days before weighing, when rain fell almost daily. The markedly increased body weights in March reflect the pasture growth resulting from this rain. The body weight gains of the young sheep were comparable with those recorded for similar animals in the same environment by Gartner, Granzien and Murray (1968).

This survey indicates that adult sheep in north-western Queensland are unlikely to show symptoms of vitamin A deficiency even after extended periods of drought. However, the vitamin A reserves of young

sheep may be depleted to levels resulting in a clinical deficiency if the length of a drought exceeds approximately seven months, which is the average length of a drought in the area (Anon. 1966).

Acknowledgments

We wish to thank Mr. J. O. Twist and Mr. A. LeFeuvre for technical assistance, and Miss P. M. Pepper for statistical analyses.

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Received for publication April 22, 1969