DROUGHT FEEDING STUDIES WITH CATTLE AND SHEEP

3. A Preliminary Note on the Use of Grain Sorghum as a Drought Fodder for Cattle.

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SUMMARY.

Eight beef-type heifers, 15-18 months old, fed for 27 weeks on 3 lb. crushed grain sorghum supplemented with ground limestone were in strong condition at the conclusion of the feeding period and made rapid weight gains when returned to pasture.

The mean loss of body weight during the first nine weeks of all-grain feeding was 10 lb. per head per week; over the final 18 weeks it was 3.3 lb. per head per week.

Serum protein, packed cell volume, plasma volume, and plasma sodium, potassium and chloride concentrations did not appear to be markedly influenced by the ration.

I. INTRODUCTION.

Franklin (1954) and Franklin, McClymont, Briggs and Campbell (1955) have shown that under experimental drought feeding conditions sheep may be successfully maintained on rations containing a high proportion of cereal grain. The omission of roughage, and use of all-grain rations for the drought feeding of sheep, was later reported by Briggs, Franklin and McClymont (1956).

Our present knowledge regarding the feed requirements of the bovine for survival is limited. Morris (1958a,b) has reported on the use of two roughages—native grass hay (bush hay) and sorghum silage—for the drought feeding of cattle. The purpose of this communication is to report some preliminary work on the use of grain sorghum, without the addition of roughage, as a drought fodder for cattle. Observations were made on the effect of the all-grain ration on body weight; serum protein concentration; plasma sodium, potassium and chloride concentrations; packed cell volume; plasma volume; and behaviour of the animals.

II. METHODS AND MATERIALS.

(1) Experimental Animals.

Eight dehorned Hereford or Hereford-dairy cross heifers, in store condition and 15–18 months of age, were taken from paspalum (*Paspalum dilatatum*) pasture, weighed, and housed in individual stalls with a concrete

floor. These animals had previously been inoculated with a tetanus toxoid and blackleg vaccine, and dipped in a 0·5 per cent. DDT solution. They were negative to the single intradermal test for tuberculosis and to serological tests for brucellosis and contagious pleuropneumonia.

(2) Method of Feeding.

For 11 days after transference to stalls, a restricted ration of lucerne hay was fed. By the end of this period the animals appeared accustomed to stall conditions and could operate the automatic drinkers. The ration was then changed over a period of three weeks according to the following schedule until an all-grain diet was being fed.

Number of Days on Ration.	Ration (lb./head/day.)	
	Grain sorghum.	Lucerne chaff.
4	2	4
4	2½	3
4	2½	2
5	2¾	1¼
4	3	½
189	3	0

The daily ration of 3 lb. crushed grain sorghum was fed between 7 a.m. and 8 a.m. except on the days on which the animals were weighed, when it was fed at 3.30 p.m. When all-grain feeding commenced, 1 per cent. calcium carbonate was intimately mixed with the grain. No salt or other additives were included. Drinking water was available *ad lib.* from the Brisbane city supply.

After 189 days (27 weeks) of all-grain feeding, the animals were returned to paspalum pasture.

(3) Body Weight.

The eight heifers were individually weighed at weekly intervals between 7 a.m. and 8 a.m. After weighing, the heifers were confined to a bare unshaded yard until 3 p.m. and then returned to the stalls.

(4) Methods of Chemical Analysis.

Proximate analysis of sorghum grain was by the methods of Association of Official Agricultural Chemists (1955), and serum protein concentration was determined by a combination of the methods of Phillips *et al.* (1950) and Van Slyke *et al.* (1950).

Plasma electrolytes were estimated on samples of blood collected from the external jugular vein. Heparin was used as an anticoagulant. These blood samples were centrifuged as soon as possible after collection to minimise exchange of chloride, sodium and potassium ions between plasma and cells. For the estimation of plasma sodium and potassium the plasma was diluted with distilled water 1 in 500 and 1 in 50 respectively and read directly on a calibrated E.E.L. flame photometer. Plasma chloride was estimated by adding to 5 ml. of plasma, 10 ml. of distilled water and then 5 ml. of 20 per cent. trichloracetic acid, shaking the mixture and allowing it to stand for 10 minutes. After filtering through a No. 40 Whatman filter paper, a 5 ml. aliquot of the filtrate was titrated electrometrically for chloride against a standard silver nitrate solution. A blank determination using distilled water in place of plasma was used to correct for the chloride content of the reagents used.

Packed cell volume was determined by the method described by Wintrobe (1947), and plasma volume by the dilution of Evans blue (T-1824) as described by Morris (1958b).

III. RESULTS.

The introduction of heifers to a ration of all-grain was achieved without incident. There was some looseness of the faeces, but at no time did diarrhoea occur. As the experiment progressed the faeces assumed a semi-solid nature, but at the conclusion of the experiment portions of undigested grain were still apparent. No metabolic disorders were apparent clinically, either in the introductory period, during all-grain feeding, or when turned out on pasture.

In Fig. 1 the group average body weights at weekly intervals are shown. Actual mean body weights at selected dates were as follows:

Period.	Mean Group Weight.
	lb.
From pasture	580
Commencement of all-grain feeding	564
After 9 weeks all-grain feeding	472
After 18 weeks all-grain feeding	449
After 27 weeks all-grain feeding	412
After 6 weeks on pasture	584
After 8 weeks on pasture	625

Values for the serum protein, packed cell volume, plasma volume and plasma sodium, potassium and chloride concentrations after 27 weeks of all-grain feeding are given in Table 1.

Table 1.

SERUM PROTEIN, PACKED CELL VOLUME (P.C.V.), PLASMA VOLUME AND PLASMA SODIUM, POTASSIUM, AND CHLORIDE CONCENTRATION OF HEIFERS AFTER 27 WEEKS OF ALL-GRAIN FEEDING.

Animal No.	Serum Protein g./100 ml.	P.C.V. %	Plasma Volume (ml./kg. body weight).	Plasma Electrolytes m-equiv./l.		
				Sodium.	Potassium.	Chloride.
1 ..	7·4	40	47	125	5·0	116
2 ..	6·1	36	46	161	4·5	130
3 ..	6·3	38	54	150	5·0	125
4 ..	5·8	39	52	135	3·8	122
5 ..	6·7	39	45	140	5·0	128
6 ..	6·8	37	45	138	5·0	122
7 ..	5·6	36	54	125	5·0	114
8 ..	5·6	37	*	130	5·0	104
Mean	6·3	38	49	138	4·8	120

* Not determined.

Rumination ceased within two weeks on the all-grain ration, and recommenced at least in some heifers on the day they were turned out to pasture. With the cessation of rumination on all-grain feeding, the heifers were observed to spend considerable time chewing the 1 in. steel bar over the feed trough. This behaviour was similar to rumination except that a bolus was not regurgitated for re-mastication.

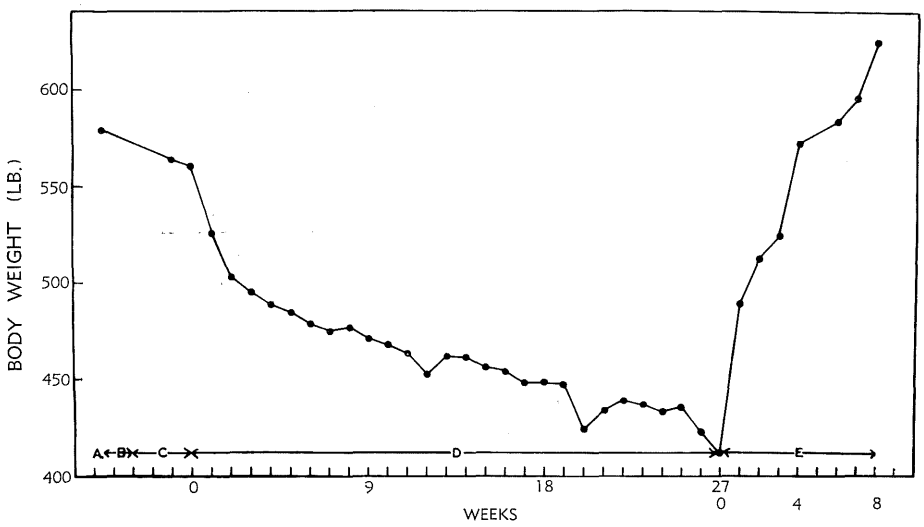

Fig. 1.

Changes in Body Weight of Heifers Prior to, During and After Feeding 3 lb. Crushed Sorghum Per Head Per Day. A., pasture, B., restricted lucerne hay ration. C., grain-lucerne mixture. D., all-grain. E., recovery on pasture.

After the experiment had been in progress for some weeks, the environment of the animals had a smell reminiscent of a pig sty.

Proximate analysis (expressed as percentages) of a sample of the sorghum grain was as follows: moisture 10·0, crude protein 10·1, ether extract 2·6, crude fibre 1·5, nitrogen-free extract 74·5, ash 1·5, calcium (Ca) 0·05, phosphorus (P) 0·27, sodium (Na) 0·04, and potassium (K) 0·13.

IV. DISCUSSION.

This preliminary experiment has demonstrated that cattle can survive without apparent metabolic or digestive upsets, other than cessation of rumination, for periods up to 27 weeks on a grain sorghum ration without any roughage.

At the level of feeding practised (3 lb. per head per day) there was considerable loss of body weight, especially in the first nine weeks of the all-grain feeding. After this period the rate of weight loss declined. This weight loss, however, did not adversely affect the animals' ability to regain body weight rapidly when returned to pasture. Part of this apparent rapid weight loss and gain is due undoubtedly to rumen "fill".

Maintenance energy requirements of cattle may be assessed from conventional feeding "standards". For a 1,000 lb. cow, Morrison (1951) allows 7·0–7·9 lb. of total digestible nutrients (T.D.N.), and Woodman (1952) allows 6·0 lb. of starch equivalent (S.E.). Brody (1945) has shown that the basal heat production of all animals varies as the 0·73 power of body weight. By applying this general relationship the mean maintenance energy requirements of the heifers at the commencement and termination of grain feeding may be computed as:—commencement 4·6–5·2 lb. of T.D.N. or 4·0 lb. of S.E.; termination 3·7–4·1 lb. of T.D.N. or 3·1 lb. of S.E.

The energy intake from 3 lb. of air-dried crushed sorghum is 2·2 lb. of T.D.N. or 2·0 lb. of S.E. if the values of 72 lb. of T.D.N. (Schneider 1947) and 68 lb. of S.E. (Hewitt 1949) per 100 lb. of air-dried material are adopted.

Although energy balance was probably not attained at any time during this experiment, the results indicate that the maintenance allowance given by feeding "standards" may over-estimate the survival requirements of cattle under stall conditions for periods up to 27 weeks. Briggs, Franklin and McClymont (1957) reported that "overseas feeding standards are too liberal when applied to the Australian Merino sheep under conditions of nutritional stress".

Serum protein levels at the conclusion of the experiment indicated that with the exception of three animals (Nos. 1, 5 and 6) the values were below 7·0 ± 0·5 g./100 ml. recorded by Bradish, Henderson and Brooksby (1954) for normal Devon steers of comparable age.

Packed cell volumes of all animals were within the range of 30–40 per cent. reported by Coffin (1953), but tended to be greater than the value of 33·7 per cent. recorded by Holman (1955).

Plasma volume of all animals was greater than the range of 36·3–40·6 ml./kg. cited by Reynolds (1953) for non-pregnant, non-lactating cows in good condition. The disparity between the values found for these experimental animals and those cited by Reynolds may be due to the effect of rumen "fill" on body weight. Taking the average plasma volume at the conclusion of the period on grain feeding and the average body weight one week after being on pasture, a value of 41·2 ml./kg. is computed. This approximates closely to the upper limit cited by Reynolds. Considering this value in relation to the condition of the animals the indications are that plasma volume was not elevated.

Our present knowledge of the sodium and chlorine requirements of bovines is limited. Work at Onderstepoort by Theiler, Green and Du Toit (1927) indicated that the growth of heifers was not affected by a ration providing only 1·5 g. of sodium and 5 g. of chlorine daily but there were calving abnormalities. Du Toit, Malan and Groenewald (1934) showed that a ration providing a daily intake of 4·2 g. sodium (Na) and 6·7 g. chlorine (Cl) was sufficient for dry cows but not for lactating cows. From the experiments at Onderstepoort (Theiler *et al.* 1927 and Du Toit *et al.* 1934), Du Toit *et al.* (1940) suggest that 1·5 g. sodium and less than 5 g. chlorine daily are sufficient for growth. These requirements of sodium and chlorine for growth are met by a ration containing 0·02 per cent. sodium and 0·07 per cent. chlorine for a dry matter intake of 16 lb. per head per day.

Cereal grains have a low sodium concentration in comparison with other feedstuffs. Barham *et al.* (1946) analysed a number of American varieties of grain sorghum: the sodium concentration was within the range of 0·014–0·041 per cent., with a mean of 0·023 per cent. Analysis of the sorghum grain fed in this experiment shows it contained 0·04 per cent. sodium and 0·13 per cent. potassium. At the level of feeding adopted in this experiment, this analysis shows a mean dietary intake of 0·49 g. sodium per head per day, which is approximately one-third the requirements for growth cited by Du Toit *et al.* (1940).

Plasma sodium concentration of six of the eight heifers after grain sorghum feeding was below the range 145–219 m–equiv./l. reported by Morris (1958b) for heifers of similar age. The values for plasma sodium which were

found conform more closely to those reported by McSherry and Grinyer (1954) of 142 ± 5 m–equiv./l. for serum of cattle 2–13 years of age, and by Murty and Kehar (1952) of 153–489 mg./100 ml. (110–213 m–equiv./l.) for the Kumaoni bullock.

Plasma chloride concentrations of all animals with the exception of No. 8 were in excess of the range of 356–386 (mean 371) mg./100 ml. reported by Lengemann, Aines and Smith (1952) for Holstein females of comparable age and the value of 103·7 ± 3·5 m–equiv./l. of McSherry and Grinyer (1954) for cows 2–13 years of age. From these results it appears that the chloride intake from crushed grain sorghum and drinking water was sufficient to prevent a depression of plasma chloride concentration.

Plasma potassium concentration with the exception of that of animal No. 4 conforms to the value of 4·85 ± 0·47 m–equiv./l. reported by McSherry and Grinyer (1954).

The effect of the addition of salt (sodium chloride) on the well-being, plasma sodium, potassium and chloride concentrations and extracellular fluid volume of cattle fed a sole diet of grain sorghum is being further investigated.

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