Cow-Calf and Stocker

Observations on the Preconditioning Effect of Wheat Pasture, It's Nutritive Value and the Health of Grazing Steers[1]

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Story in Brief

A study of two beef cattle stocker production systems used during the winter months on the Southern Great Plains was conducted to determine (1) which of the two systems yielded the greatest beef production and (2) whether or not the winter feeding program had a "hold over" effect which altered subsequent feedlot performance. Closely related studies were conducted to define the nutritive qualities of winter wheat pasture herbage. The winter feeding programs compared were (1) wheat pasture and (2) dormant bermudagrass pasture plus bermudagrass hay and 1.8kg. (4 lb.) per head per day of 30 percent C.P. range cubes.

Stocker steers on wheat pasture gained 0.75kg. (1.68 lb.) per head per day during the grazing period from December 10, 1971 to March 15, 1972; steers on the bermudagrass treatment gained only 0.36kg. (0.86 lb.) per head per day ($P<.01$). In the feedlot, in terms of average daily gain, feed intake, and feed efficiency, there were no differences between steers previously grazed on wheat pasture versus bermudagrass. Laboratory evaluations of wheat pasture herbage suggested that high body weight gains can be attributed to the high protein content and digestibility of the forage. Plant and blood mineral values suggested that wheat pasture may provide a diet too low in available calcium and magnesium and too high in phosphorus. The level and availability of protein in wheat pasture may be responsible for amino acid imbalances in the

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animal as well as potentially toxic levels of ammonia production in the rumen.

Introduction

Most research on the utilization of winter wheat in stocker cattle production systems has been aimed toward determining effects of supplementation of the diet with various mineral mixes, use of diethylstilbesterol in wheat pastured animals or effects of grazing upon grain yield. It is estimated that there are more than four million acres of winter wheat grown annually in Oklahoma alone, and that as many as 1,000,000 head of stocker cattle and cows may graze this forage crop each year, yet little or no research has been conducted to define the nutritive characteristics of the wheat plant or to relate animal health and performance to change in the composition of the forage.

As many as three percent or more of the animals turned out on wheat pasture each year die from undetermined causes, yet, until recently, there has been little effort directed toward finding solutions to this costly problem. The objectives of this experiment were 1) to assess the nutritive qualities of wheat pasture, 2) to determine whether or not growing beef cattle grazed on winter wheat perform better in the feedlot than do animals wintered by another typical means and 3) to gain some insight into the complex factors causing death losses of cattle on wheat pasture.

Materials and Methods

Four hectares (9.9 acres) of Triumph winter wheat were established on a Canadian fine sandy loam type soil in September, 1971 and top-dressed with 56kg.N/ha. (50 lb. N/acre) as ammonium nitrate. Hand-clipped samples were collected weekly from November 1, 1971 to April 11, 1972 for analysis of dry matter (DM), crude protein (CP), acid detergent fiber (ADF), acid detergent lignin (ADL), neutral detergent fiber (NDF), cellulose, total ash, 48 hour *in vitro* dry matter disappearance (IVDMD), rate of IVDMD, gross energy, and minerals (Ca, P, Cu Mg, Mn).

Sixteen ¾ Angus X ¼ Holstein steers weighing 230 kg (506 lb.) equipped with rumen fistulae were randomly allocated to two pasture treatment groups for the grazing period December 10, 1971 to March 15, 1972; then within each pasture treatment group, randomly allocated to two feedlot treatment groups until May 9, 1972. Pasture treatments included 1) wheat pasture and 2) dormant bermudagrass pasture + ber-

mudagrass hay free choice + 1.8kg. per head per day of "range cubes" (30 percent crude protein). In the feedlot the animals were raised from an *ad lib* 50 percent concentrate ration to a 90 percent concentrate ration in either two weeks (fast) or four weeks (slow). The animals were penned and fed individually. During the pasture phase, weekly samples of blood plasma were collected for analysis of free amino acids. During the entire experimental period, weekly samples of blood serum were collected for analysis of minerals (Ca, P, Mg, Cu, Zn, and Mn). Ruminal fluid samples were collected weekly for analysis of pH and ammonia concentration.

Results and Discussion

Chemical Composition Studies[1]

Results of acid detergent fiber (ADF) and lignin (ADL) analyses are presented in Figure 1. Wheat pasture herbage is only about 20 percent dry matter as it stands in the field, but on a dry-matter basis, it has

[1] For information regarding the relationships of the various chemical fractions to animal performance, it is suggested that the reader refer to a recent review (Horn, 1972).

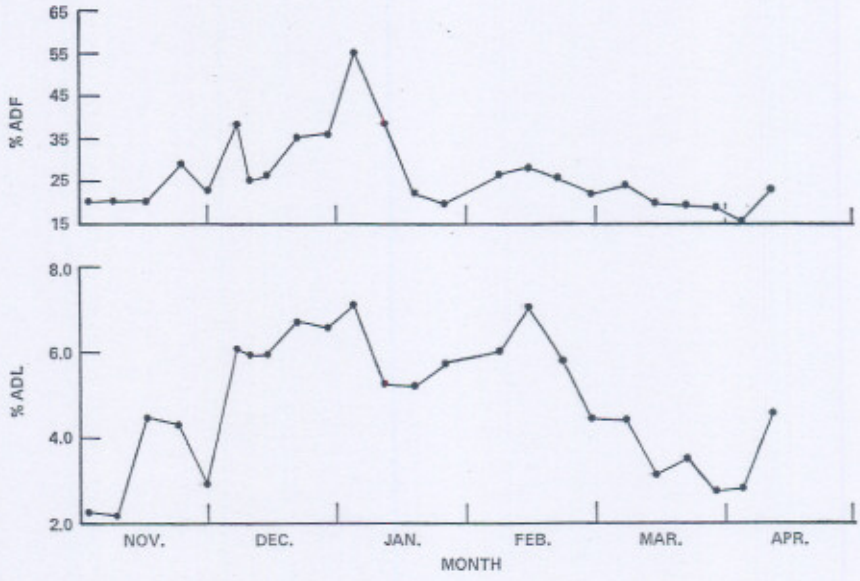

Figure 1. Changes in acid detergent fiber and lignin levels in winter wheat pasture herbage during the 1971-72 grazing season.

many of the chemical characteristics of other cool-season grasses. ADF ranged from 15 to 56 percent of the dry matter. The pattern of changes seemed to reflect changes in the weather; as one would expect, the fall and spring periods of rapid growth were associated with very low ADF levels, but in the winter months of December and January, when almost no plant growth occurred, fiber levels rose markedly. It is important to note that the sampling site was subject to moderate grazing pressure during most of the experimental period. Thus, the changes one would expect because of plant maturing processes were at least reduced considerably.

Lignin values (ADL) were also highest during periods of lesser growth, but at no time did lignin appear at *very* high levels. In a "normal" year the fiber and lignin levels would probably have remained at their highest through February, but in 1972, an extended warm spell prevailed throughout most of that month.

Neutral detergent fiber (NDF) changes were very similar to other fiber changes as would be expected (Figure 2), with values ranging from 27 to 57.5 percent. Total ash values were very high during December and January. In an effort to determine whether soil contamination might have caused the high values, soil silicate was measured as part of the Van Soest fiber fractionation. There were two samples, both taken in early January, which the data suggested contained some soil contaminants, but most of the samples did not contain measurable soil silicates. To reaffirm this finding, studies are in progress in which the ash content of washed and unwashed hand-clipped samples of wheat will be compared.

In vitro dry matter dissappearance values and crude protein values appear in Figure 3. Wheat pasture herbage, as can be seen, was rich in protein. Values ranged from 33.7 percent C.P. in mid November to 14 percent in April. Levels in excess of 20 percent were the general rule throughout the grazing season. The National Research Council (N.R.C.) in the Nutrient Requirements of Beef Cattle, revised in 1970, indicated that growing steers or heifers weighing 300 kg. required 11.1 percent total protein in the diet when they are expected to gain 0.75 kg. body weight per day. This figure of 11.1 percent assumes a protein digestibility of 74 percent; hence, the digestible protein requirements of these animals is shown as 7.1 percent of the dry diet. Wheat pasture apparently has a protein content which is readily available to the animal.

In vitro dry matter disappearance (Tilley and Terry, 1963) ranged from 48 to 76 percent. Simple correlation coefficients were calculated to define relationships between in vitro digestibility and crude protein, ADF, ADL, NDF and ash. The correlation coefficient relating IVDMD to crude protein was 0.55. Those relating the *in vitro* value to ADF, ADL and NDF, respectively, were —0.63, —0.70 and —0.78. The coefficient

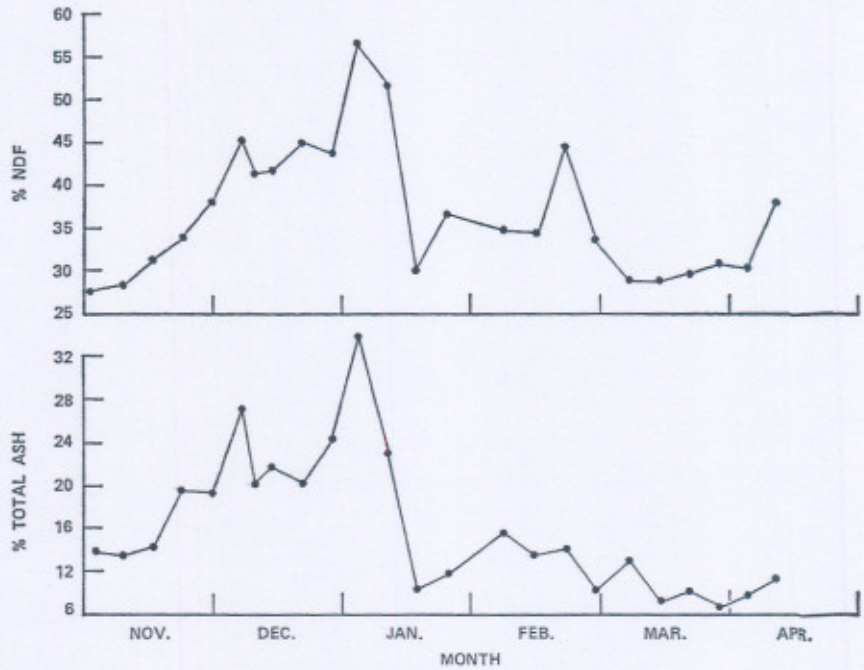

Figure 2. Changes in neutral detergent fiber and total ash levels in winter wheat pasture herbage during the 1971-72 grazing season.

relating in vitro dry matter dissappearance to ash was —0.77. None of the relationships, then, which one might use to develop prediction equations, were strong, although those relating digestibility measurements to ADF, ADL, NDF and ash were significant at the 0.05 level.

The two-stage *in vitro* dry matter digestion technique was used again to determine the rate-of-digestion of wheat pasture herbage (Figure 4). In this case the wheat pasture was compared to a bermudagrass standard. Ruminal fluid digestions were terminated after 4, 8, 12, 24 and 48 hours of incubation, then the pepsin digestion was carried out, and samples were dried and weighed. The average values for bermudagrass after 4, 8, 12, 24 and 48 hours were 23.5, 26.0, 30.7, 42.3 and 51.5 percent, respectively. Corresponding values for wheat pasture herbage were 55.5, 60.5, 63.6, 68.4 and 70.2, respectively.

To summarize chemical composition results, then, it has been established that wheat pasture is low in fiber, especially in periods of rapid

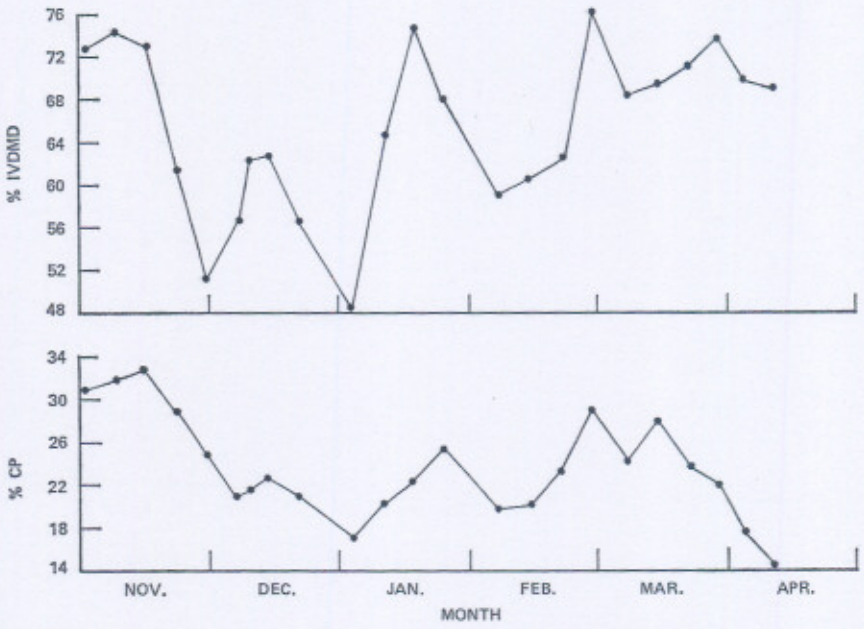

Figure 3. Changes in *in vitro* dry matter digestibility and crude protein content of winter wheat pasture herbage during the 1971-72 grazing season.

growth. Furthermore, it is very high in protein, and lastly, it is highly and rapidly digested.

Animal Studies

Plasma levels of free non-essential amino acids are shown in Table 1. Mean values are expressed as micro-moles per 100 ml. of plasma. Wheat pasture animals had significantly higher levels of glycine, serine, and cystine (level of significance is indicated on the right side of the table). There were no significant differences at the .05 level in the alanine, tyrosine, aspartic acid, glutamic acid, proline, hydroxy proline, or citrulline levels among the two pasture treatment groups.

More striking differences were apparent in the essential amino acid group. (Table 2) Highly significant differences ($P<0.001$ or less) in phenylalanine, leucine, isoleucine, threonine and valine were noted. Levels in the plasma of animals from the wheat pasture group were, in each case, higher than were levels in the plasma of bermudagrass fed cattle. Lysine was significantly ($P<0.05$) higher in wheat pasture steer plasma than it was in the bermudagrass fed steers.

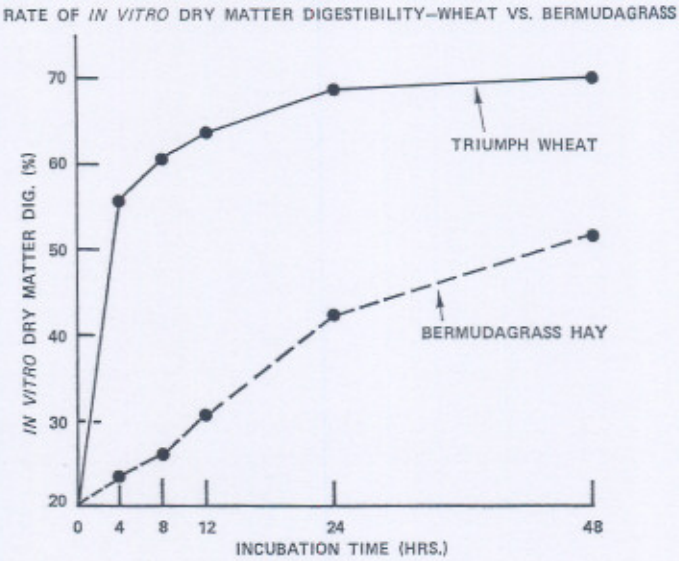

Figure 4. Comparison of the rate-of-digestion of bermudagrass hay vs. winter wheat pasture herbage.

Table 1. Non-Essential Amino Acid Levels in Plasma from Steers Grazing Wheat or Bermudagrass Pastures

Amino acid	Mean Plasma Concentration (μM/100 ml serum)		Level of significance
	Wheat pasture	Bermudagrass	
Glycine	36.18	27.97	$P \leqslant 0.01$
Alanine	23.30	22.39	NSD
Serine	10.10	8.03	$P \leqslant 0.005$
Cystine	1.59	0.99	$P \leqslant 0.05$
Tyrosine	5.10	4.54	NSD
Aspartate	1.05	0.83	NSD
Glutamate	14.57	15.77	NSD
Proline	10.01	9.29	NSD
Hydroxyproline	5.59	6.39	NSD
Cittruline	5.91	5.34	NSD

Caution must be exercised when interpreting these results, especially in view of the fact that protein intake was not measured and since composition of the dietary proteins was not determined. Nevertheless, two conclusions may be drawn from these data. First, the wheat pasture diet

Table 2. Essential Amino Acid Levels in Plasma from Steers Grazing Wheat or Bermudagrass Pastures

Amino acid	Mean Plasma Concentration (μM/100 ml serum)		Level of significance
	Wheat pasture	Bermudagrass	
Lysine	17.62	11.29	$P \leqslant 0.05$
Tryptophan	1.53	1.19	NSD
Histidine	5.85	4.82	NSD
Phenylalanine	5.87	4.66	$P \leqslant 0.01$
Leucine	18.27	13.21	$P \leqslant 0.0001$
Isoleucine	12.19	9.43	$P \leqslant 0.0001$
Threonine	8.36	5.42	$P \leqslant 0.0001$
Methionine	1.72	1.55	NSD
Valine	32.80	23.66	$P \leqslant 0.0001$
Arginine	31.16	22.58	NSD

was providing a higher quality protein than the bermudagrass diet. This is evident since, in all cases, the amino acid levels were higher in wheat cattle than in bermudagrass cattle. Secondly, there do not appear to be any limiting amino acids clearly indicated.

Calcium levels in the serum of all steers were low (Figure 5). The normal range is 9 to 12 mg./100 ml. Values in the bermudagrass group represented by the solid line range from about 6.8 to 9.6 mg., and those in wheat pasture animals were even lower, ranging from about 4.9 to 6.7 mg./100 ml. of serum. Mean differences between the pasture treatment groups, while they approached significance, were not different at the 0.05 level. In this regard, it should be mentioned that for these particular analyses only 4 animals per treatment were included. Remaining blood samples from this group are presently being analyzed, but it seems reasonable to suggest that real differences between the two groups probably did exist.

It is not possible to determine how much calcium was in the diet of individual steers in the bermudagrass group, but to help in understanding the wheat pasture-blood calcium results, calcium contents of wheat samples collected weekly were determined. Plant calcium values ranged from 0.15 to 0.60 percent of the dry matter, with a mean of 0.42 percent. The National Research Council (NRC) in the Nutrient Requirements of Beef Cattle, revised in 1970; indicated that growing steers of the size used (about 300 kg.) and gaining 0.75 kg. body weight per day, require 0.21 percent calcium in the dry diet. Phosphorus levels in the wheat pas-

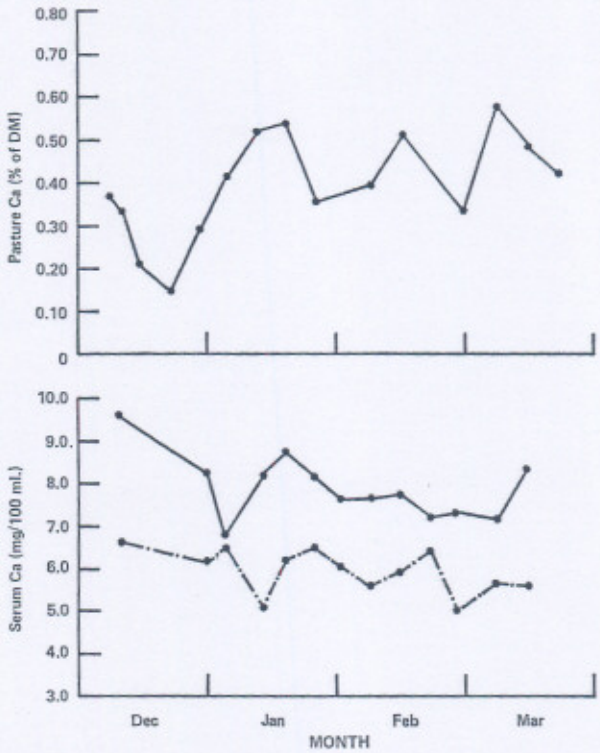

Figure 5. Changes in calcium content of winter wheat, and in serum concentrations of calcium in bermudagrass-fed steers (____), and wheat pastured steers (__.__) during the 1971-72 grazing season.

ture herbage ranged from 0.37 to 1.00 percent of the dry matter with a mean of 0.67 percent. The NRC has indicated that if 0.18 percent of the dry diet is phosphorus, minimum requirements should be met.

It has been recognized for many years that a calcium: phosphorus ratio of perhaps 2 to 1 is desirable for beef cattle rations. Results from this study, as well as other unpublished data from the Okla. Agr. Expt. sta. suggest that the Ca:P ratio in wheat pasture herbage is more often 1 to 2 or more. This imbalance may have been responsible for the low blood calcium values.

Blood serum and forage magnesium levels are presented in Figure 6. Serum from animals grazing wheat pasture contained significantly lower levels ($P<0.05$) of Mg as indicated by the broken line, than did serum

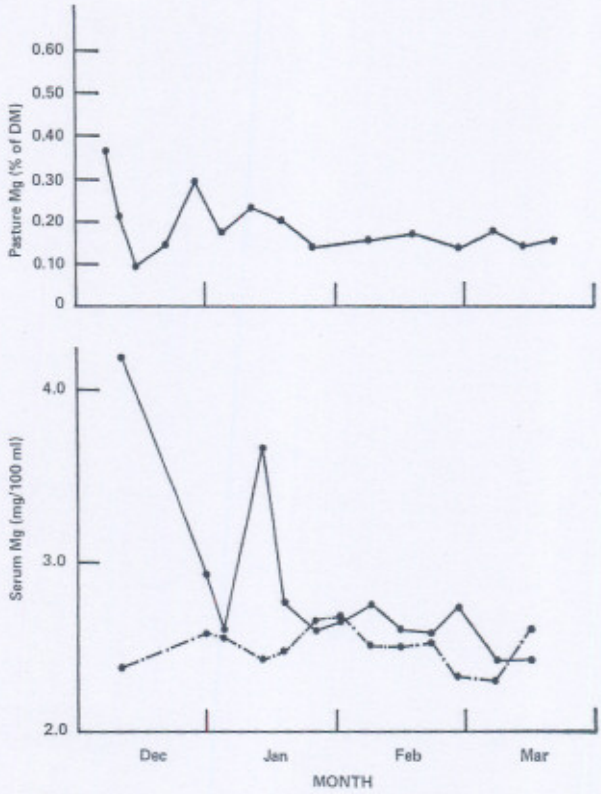

Figure 6. Changes in magnesium content of winter wheat, and in serum concentrations of magnesium in bermudagrass-fed steers (_____), and wheat pastured steers (__.__) during the 1971-72 grazing season.

from bermudagrass fed steers. Nevertheless, all values were within the normal range for cattle, 2 to 5 mg./100 ml. Small grains pastures are known to be low in Mg, and, indeed, the magnesium content of wheat samples collected were less than levels suggested for prevention of tetany. Underwood has indicated in his book *The Mineral Nutrition of Livestock* (1966) that less than 0.20 percent Mg in the dry diet led to incidence of grass tetany. This problem has been of importance in the Southern Great Plains where cows have been turned out on wheat pasture-hence the term Wheat Pasture Poisoning to denote hypomagnesium tetany. These data, however, suggest that wheat pasture herbage is normally capable of meeting the Mg. requirements of stocker animals.

The high protein content of wheat pasture was, as would be expected, associated with high ruminal pH values. Mean pH measurements ranged from 6.2 to 7.6 in animals consuming wheat pasture, while individual readings often went up to 8.0.

Ruminal ammonia concentrations are presented in Figure 7. Very high, potentially lethal levels, were recorded in wheat pastured steers as designated by the solid line during late February to mid March. Recall that high levels of crude protein were accumulated in the wheat plant at that time. Mean ruminal ammonia concentrations were not significantly different at the .05 level among pasture treatment groups.

During the 50 day feedlot phase, average daily gains were nearly identical between the wheat pasture and bermudagrass steers. Steers previously grazed on wheat pasture averaged 1.91 kg. per day (4.20 lb.) versus 1.92 kg. (4.21 lb.) for those previously grazed on bermudagrass. Moreover, there were no significant differences in feed intake or feed / unit of gain for the wheat pasture vs. bermudagrass cattle. In addition, no diffrence in performance existed between steers raised to an *ad lib* 90 percent concentrate ration in either two weeks ("fast") or four weeks ("slow").

In closing it would be well to summarize the results and comment briefly on the potential significance of these data. One of the objectives

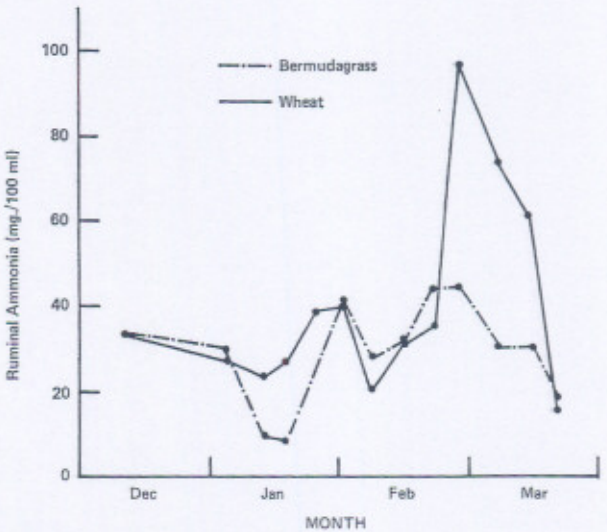

Figure 7. Changes in the average reminal ammonia concentration of steers grazing winter wheat during the 1971-72 grazing season.

of this research was to provide some insight into metabolic disturbances causing death losses in stocker cattle grazing wheat. In that sense, this was partly a preliminary study. Several factors of potential importance have come to light, and areas for further study are suggested.

) 1. Wheat pasture is very high in a readily available protein. This may, under certain circumstances, cause toxic levels of ammonia to be formed in the rumen.

2). The physical characteristics of ruminal contents in animals grazing wheat pasture are such that rumen motility and, hence, the eructation (belching) mechanism may be impaired; thus, animals could bloat.

3). The high moisture content of the wheat plant may make it impossible, during some periods in the grazing season, for the animal to satisfy daily dry matter requirements.

4). Wheat pasture herbage is very highly and rapidly digested. Undoubtedly gas formation in the rumen is extensive.

5). While the magnesium content of wheat pasture herbage is low, it appeared to be adequate for prevention of tetany in growing steers or heifers. It is suggested that the "stocker syndrome" is not the same syndrome as is seen in lactating cows.

6). The calcium:phosphorus ratio in wheat pasture herbage may not be acceptable for optimum performance.

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