Table 7: Slaughter and Carcass Information of Steer Calves With and Without Supplemental Vitamin A

	Supplemental Vitamin A	
	0	1,000 I.U./lb. Ration
Dressing %*	60.8	61.0
Quality grade**	8.8	8.9
Ribeye area, sq. in.***	10.0	9.9
Fat over ribeye, in.†	.68	.71
Trimmed retail cut yield, %††	48.1	46.4

*Calculated on basis of shrunk Ft. Reno live weight and chilled carcass weight.

**U.S.D.A. quality grade converted to following numerical designations: high prime—15, average prime—14, low prime—13, high choice—12, average choice—11, low choice—10, high good—9, average good—8, low good—7.

***Determined by measurement on tracings of the ribeye.

†Average of three measurements determined on tracings of the ribeye.

††Calculated as follows: % of carcass as boneless trimmed retail cuts from the four major wholesale cuts = 51.34 − 5.78 (fat thickness) − .462 (% kidney fat) + .740 (ribeye area) − .0093 (carcass weight).

ground product may be less desirable in high concentrate rations, and certain management factors may also influence the choice of grind. For example, if neither molasses nor fat is used, a coarsely ground or rolled milo may be most desirable due to the dustiness of finely ground milo.

The addition of supplemental vitamin A (1,000 I.U./lb. of ration) to a ration containing 10% alfalfa and milo as the grain was of little apparent benefit.

Trace Mineral Supplements to "All-Barley" Rations For Fattening Steers

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A serious problem to cattle feeders in the Southwest during recent years has been the high cost of roughage in finishing rations. Most feeders now use much more grain than in the past, and drop the roughage to 10-15%, in finishing rations. It has been possible in experiments to reduce the roughage content to zero and depend on steam-rolled grains for the necessary bulk in the diet.

Experiments at several stations over the past 5 years have demonstrated that steamed rolled barley, properly supplemented, can make up the entire ration. Studies at the Ft. Reno station have been designed to

determine the mineral deficiencies when all-barley rations are fed.[1] From these studies, it has been shown that an "all-barley" ration is quite efficient for finishing cattle (i.e. less than 7.5 lb. feed per lb. gain) provided care is taken in formulating the supplement. When all, or nearly all, of the roughage is removed from fattening rations, it is obvious that the supplement has to carry the load and supply the nutrients essential for proper growth and fattening.

In the mineral fraction likely to be deficient, our studies show that certain trace minerals are most important. It was observed that when all-barley rations were supplemented with trace minerals, appetite improved and rate of gain was increased. In the trial reported herein, an attempt was made to determine some of the trace minerals responsible for increasing the feed intake and performance of steers on all-barley and soybean meal rations, and to compare the mineral-supplemented diets with those containing dehydrated alfalfa meal and molasses. It seemed possible that these natural feeds might supply nutritional factors above and beyond their trace mineral content which would be worth investigating.

WHY TRACE MINERALS ARE IMPORTANT

Normally, in most rations, natural feeds, such as legume roughages provide enough trace minerals. Trace minerals are known to be closely associated with red blood cell formation, and with various enzyme systems within the body. Some trace minerals serve as component parts of enzymes, while others are known to be activators or catalysts for certain enzymes. This means that the trace mineral must be present in order for the enzymes to be active and perform a vital function within the body. Enzymes have long been recognized as serving many important functions in the metabolism of food nutrients. Each enzyme is designed by nature to control a specific reaction. Since certain trace minerals function as a part of the red blood cells, or in their formation, plus the release of energy from carbohydrates, it is obvious that performance can be greatly affected on rations deficient in any one of the several essential trace minerals. Elsewhere in this Feeders' Day report is a more complete discussion of trace minerals.

If ruminants lack certain trace minerals, such as cobalt, we often observe a depressing effect on appetite and performance. Less bacterial activity may occur in the rumen, resulting in a lower feed intake. Naturally this would lead to a reduction in daily gain. The situation may become especially acute where roughage is withdrawn from the ration, since many grains are poor sources of trace minerals. Few studies have been made of the exact trace mineral needs of steers on all-barley diets.

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[1] See Oklahoma Mis. Pub. MP-67 and MP-70.

PROCEDURE

One hundred, weaner, Hereford steer calves were purchased in October, 1962, from the Schultz Ranch near Shattuck. The calves were branded for individual identification and placed on 50 acres of excellent barley pasture, with an adjacent 100 acres of dead grass and milo stubble. During the 101-day winter grazing period, the calves averaged 0.9 lbs. gain per day. At the end of the grazing period, 64 of the most uniform steers were selected for random allotment to sixteen groups of 4 steers each.

Table 1 shows the four treatments which were used in this study. The design called for four replications, or pens, of steers within each treatment. Differences in the feeding value of two sources of Rogers barley, produced at Ft. Reno vs. that obtained from a local mill and produced in north central Oklahoma, were also compared since two groups within each treatment were fed each of the two barleys.

The steers were placed on full-feed April 1, and were self-fed for 122 days. Cottonseed hulls were added to the rations (50% initially) during the early part of the feeding trial, and withdrawn at weekly intervals until all hulls had been removed from the ration by the end of the fifth week. A supplement based on soybean meal fortified with calcium and vitamin A was fed all lots as small pellets, at the rate of 1.5 lb. per steer daily. Slightly less supplement was fed Lot 4 steers receiving dehydrated alfalfa and molasses.

In addition to initial and final shrunk weights, and weights at 28-day intervals, carcass data were obtained at the completion of the trial. In one group (Lot 4) the calves received 1.0 lb. dehydrated alfalfa meal and approximately 0.6 lb. molasses to see if these natural feeds would further stimulate gains over the trace minerals being studied. The

Table 1. Supplements to Steam-Rolled Barley Rations in Steer Fattening Experiments.

Lot No.*	Supplement
1	Basal**
2	Basal + Iron (Fe), Cobalt (Co) and Zinc (Zn)***
3	Basal + 6 trace elements, Fe, Co, Zn, Copper, Managnese and Iodine***
4	Basal with 1.0 lb. dehydrated alfalfa meal + 0.6 lb. molasses

* Four replications of 4 steers per treatment, with two replications within treatment on barleys from different areas of the state.

** Basal supplement fed at the rate of 1.5 lb. contained soybean meal with 6% calcium carbonate and sufficient vitamin A to supply 27,000 I.U. per steer daily.

*** Trace mineral supplements added at the following levels (mg.): Fe, 1000; Cu, 40; Co, 3; Zn, 300; Mn, 163; and I, 1.

alfalfa meal was pelleted in 3/16 inch cubes and mixed with the rolled barley supplement, and 3% molasses was added to the complete mixture. No additional minerals other than salt, free choice, were available to the cattle.

RESULTS

The average results of the feeding trial are shown in Table 2. The need for trace mineral supplementation when "all-barley" diets are used is clearly indicated.

The mineral supplement fed Lot 2 steers containing iron, cobalt and zinc resulted in the highest average daily gain. A smaller response was obtained with the supplements fed Lots 3 and 4 which supplied 6 different elements, or dehydrated alfalfa meal and molasses. Feed intake data clearly show the "appetizing" effect of the additional trace minerals.

It would appear that there is no advantage in average daily gain from adding any trace minerals beyond zinc, cobalt, and iron. Neither was there any advantage from small amounts of dehydrated alfalfa and molasses vs. these minerals. Thus, there appeared to be no extra stimulatory factor in the natural feeds over the trace minerals they supplied. Bear in mind that all rations were fortified with sufficient calcium and vitamin A.

Feed efficiency favored the rations containing trace minerals or dehydrated alfalfa and molasses. The greatest feed efficiency was obtained in Lot 2, where zinc, cobalt and iron were added. It required only 7.42 pounds of feed to produce a pound of gain on this ration, as compared to 8.04 pounds of feed on the control diet. The addition of less than ½ lb. of trace mineral mixture per steer during the trial in Lot 2 reduced feed per 100 pounds gain and resulted in nearly 70 lb. extra gain for each steer over the basal (Lot 1).

Table 2. Comparison of Three Supplements to All-Barley Rations

Ration	Basal Supplement (Control)	Basal Plus Zinc, Cobalt Iron	Basal Plus All Trace Minerals	Basal Plus Dehy. Alfalfa Molasses
No. steers	16	16	16	16
Av. weights lbs.				
Initial	666	685	677	680
Final	983	1075	1046	1038
Total gain, 122 days	317	390	369	358
Av. daily gain, lb.	2.60	3.19	3.03	2.94
Av. daily feed intake lb.	20.9	23.7	23.6	23.0
Feed required per cwt. gain, lb.	804	742	780	781
Av. carcass grade score*	8.94	9.37	9.62	9.31

*8 = Av. Good, 9 = High Good

In this, as in previous trace mineral studies with barley, it appears that zinc and cobalt may be the two most important trace elements lacking. In other studies, we have failed to show a consistent advantage for the addition of iron.

From the results of 6 trials, it would appear that the trace minerals required by fattening steers on all-barley diets are approximately as shown in Table 3.

Carcass grades were slightly improved by the supplements added to the basal diet. This might be expected, since the lowered feed intake of Lot 1 steers resulted in slower gains. No appreciable difference was noted in response to barley produced in two different locations in Oklahoma, as shown in Table 4, despite some variation in trace mineral content.

At the completion of the trial, samples of rumen fluid were taken by a stomach tube for determination of volatile fatty acid levels. The results, shown in Table 5, exhibit an erratic trend, but in all cases a very narrow acetic: propionic ratio was observed, when compared to other data obtained with higher roughage diets. Note the tendency for a wider ratio where the rations contained dehydrated alfalfa meal and molasses. It is presumed that a narrow ratio is more desirable for fattening cattle, and may be one reason for the good efficiency obtained on all-barley diets.

SUMMARY

All-barley rations supplemented with soybean meal, calcium, and vitamin A were fortified with trace minerals. This resulted in greater daily feed intake, increased average daily gains, more efficient feed conversion, and better grading carcasses. The most favorable response was obtained with a combination of zinc, cobalt and iron. Rations supplemented with dehydrated alfalfa meal and molasses gave slightly lower average daily gains and less daily feed intake than those containing the trace minerals. There appeared to be no advantage for the nutritional factors in dehydrated alfalfa meal or molasses other than trace minerals. Similar results were obtained when two samples of

Table 3. Suggested Trace Mineral Needs of Fattening Yearling Steers

Element	Suggested Requirement
	(Mg./day)
Iron	600
Copper	60
Cobalt	3
Zinc	520
Manganese	140
Iodine	0.6

barley grown in different locations in the state were compared. The need to fortify all-concentrate diets with trace minerals is indicated. Further studies are underway to show which trace elements are most critical.

Table 4. Chemical Composition of Rogers Barley Produced in two Different Areas of Oklahoma and Steer Performance.

Source of Barley	Ft. Reno	North Central Oklahoma
Chemical Composition, %:		
Dry matter	89.8	89.3
Crude protein	10.97	11.47
Ether extract	1.95	1.76
Crude fiber	5.18	4.92
N-free extract	69.13	68.45
Calcium	.06	.07
Phosphorus	.38	.43
Mineral Matter, %:*		
Iron, ppm.	42.8	51.5
Copper, ppm.	4.81	5.45
Cobalt,, ppm.	0.071	0.016
Manganese, ppm.	14.4	10.1
Zinc, ppm.	17.4	31.3
Iodine, ppm.	0.096	0.04
Steer Performance:		
Av. daily gain	2.97	2.91
Av. daily feed intake, lb.	23.0	22.6
Feed required per lb. gain, lb.	7.74	7.77

* As determined spectrographically by a commercial laboratory.

Table 5. Volatile Fatty Acid Patterns in Rumen Samples From Steers Fed Differently Supplemented Barleys. (Mole %)

Supplement	Basal	Basal + Fe Cu, & Co	Basal + All TM	Basal + Dehyd. Alfalfa + Molasses
Acetic				
Ft. Reno*	54.3	55.4	48.8	53.3
N. C. Okla.*	40.0	50.1	42.3	53.7
Propionic				
Ft. Reno	34.5	33.9	43.0	32.9
N. C. Okla.	48.6	41.2	46.6	36.2
Butyric				
Ft. Reno	9.3	8.5	6.9	11.3
N. C. Okla.	12.0	6.8	9.3	8.2
Av. Acetic/Propionic Ratio	1.2:1	1.4:1	1.0:1	1.6:1

* Denotes barley produced at Ft. Reno vs. North Central Oklahoma.