Alfalfa Hay and Dehydrated Alfalfa Meal in Milo and Sorghum Silage Rations for Fattening Steer Calves

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Alfalfa Hay and Dehydrated Alfalfa Meal in Milo and Sorghum Silage Rations for Fattening Steer Calves[1]

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Grain sorhums available for fattening cattle have increased greatly in the southwest, particularly with new combine-type varieties. Costs of fattening cattle (in which grain is 75% or more of feed cost) have been reduced. Since fattening cattle in drylot is the most costly part of a beef enterprise and entails tremendous risk, the proper balancing of rations needs much attention. The kind and amount of supplement necessary to balance out deficiencies of other ration ingredients becomes vitally important.

Recent research at several stations (1, 2, 3 and 4) indicate that alfalfa hay, dehydrated alfalfa meal, or alfalfa ash may contain certain nutritional factors which will improve cellulose digestion and thereby the performance of fattening cattle. Hence a study with fattening steer calves was undertaken to test the value of varying amounts of alfalfa hay or dehydrated alfalfa meal, as well as the carotene or minerals contained in small amounts of alfalfa, on gains, feed efficiency and carcass merit. In these experiments, milo was used as the grain and sorghum silage as the roughage.

Procedure

Essentially the same procedure was followed in all trials. Weanling Hereford steer calves, weighing 450-550 lbs., were obtained either from the Experiment Station herd or from large commercial herds in the state. Calves were purchased in the fall of 1953 from the Moon Ranch at Mill Creek; in 1952 and 1954 from the E. C. Mullendore Ranch at Pawhuska, and in 1955 from John Dunn at Arnett. In each year, at least part of the calves were obtained from the experimental herds at Ft. Reno, Wilburton or Lake Carl Blackwell.[3]

In all tests, the calves were trucked to the Experimental Feeding Shed immediately after weaning, and were given approximately 3 weeks to recover from the effects of weaning and to become accustomed to changes in feed. A shrunk weight (16 hours off feed and water) was

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[3] Individual data for these trials may be found in Okla. Agri. Exp. Sta. Misc. Publ. MP-31, MP-34, MP-43, & M-45 for years 1953, '54, '55 and '56, respectively.

obtained at the beginning and end of the trial to reduce differences in fill. The calves were divided into uniform groups on the basis of shrunk weight, feeder grade, source and sire (wherever possible); the groups were then assigned to treatment at random.

The feeding tests continued for approximately 165 days (late October to mid-April). The calves were started on their experimental rations the evening after allottment was made. At the start of the trial, the calves of the basal lot received approximaely 2½ lb. of rolled milo, 1.8 lb. of cottonseed meal (plus varying quantities of alfalfa hay or dehydrated alfalfa meal pellets for experimental lots), and about 15 lb. of sorghum silage per head daily. Over the first 30-45 days of the trial, the milo was gradually increased until the cattle were consuming approximately 2 lb. per cwt., or as much as they would consume. Silage was decreased gradually to a minimum level of 8 lb. per head daily. One-half the daily allowance of each ration ingredient was fed morning and evening, except where only 1.0 lb. of alfalfa hay was fed. This limited amount was fed only in the morning.

A mineral mixture of 2 parts salt and 1 part steamed bone meal was available to all cattle during the trial. In the last three trials, 1 ounce of calcium carbonate was added to the ration of all steers receiving less than 2 lbs. of alfalfa hay or pellets. In the fall of 1954, 1955 and 1956, the calves were drenched before the start of the trial with phenothiazine for the control of internal parasites. In all trials, the cattle were sprayed with rotenone and BHC for control of grubs and lice.

At the completion of the test, a shrunk weight (16 hours off feed and water) was obtained. The cattle were continued on their respective rations for approximately 10 days for display at Feeder's Day. The following day they were trucked to Oklahoma City, slaughtered and carcass data were obtained. These data included dressing percentage and carcass grade to the nearest one-third. From the actual yield of carcass beef and its current value according to grade, a live animal value per cwt. was calculated. Average chemical composition of feeds and prices, by years, are given in Appendix Table I, with feed costs used in Appendix Table II.

Four trials were conducted in which alfalfa hay or dehydrated alfalfa meal pellets replaced one-fourth or one-half of the cottonseed meal on an equal-protein basis in fattening rations. In three trials, dehydrated alfalfa meal pellets replaced all the cottonseed meal. The alfalfa hay was from the second and third cuttings at the Ft. Reno station. Dehydrated alfalfa meal was purchased in June each year from plants at Verden or Pauls Valley, Oklahoma. It was processed immediately into 3/8-inch pellets and stored on the concrete floor of the steer shed.

Results and Discussion

The results of the first trial in which alfalfa hay replaced one-fifth and two-fifths of the cottonseed meal (1.0 and 3.0 lb. per steer daily) are shown in Table 1. Average daily gains were increased from the use of either alfalfa product, although these differences were not statistically significant. Neither the form, nor the amount, of alfalfa fed appeared to be important. Calves fed the alfalfa hay to replace one-half of the cottonseed meal (Lot 3) consumed more milo, but were less efficient in conversion of milo to gain than those fed dehydrated alfalfa meal (Lot 4). In lots receiving alfalfa hay or pellets, feed costs per cwt. gain were decreased from $1.00 to $1.58 by the substitution for one-fifth

Table 1.—Effect of Substituting Alfalfa Hay or Dehydrated Alfalfa Meal Pellets for Part of the Cottonseed Meal in Fattening Rations for Steer Calves. (Trial I, 1952-53, 163 days, 10 steers per lot)

Lot Number	1	2	3	4
Source of Protein in Supplement	C. S. Meal	4/5 CS Meal 1/5 Alf. hay	2/5 CS Meal 3/5 Alf. hay	2/5 CS Meal 3/5 Dehyd. Alf. Meal
Ave. daily gain (lb.)	2.03	2.26	2.20	2.26
Ave. daily ration (lb.)				
Milo	11.25	12.51	12.30	11.62
Cottonseed meal	1.91	1.50	.80	.80
Alfalfa hay		1.00	3.00	
Dehydrated alfalfa meal pellets				2.45
Sorghum silage	8.58	7.92	6.31	7.68
2-1 mineral mix[1]	.04	.04	.04	.04
Feed required per cwt. gain (lb.)				
Milo	554	554	558	513
Cottonseed meal	94	66	36	35
Alfalfa hay		44	136	
Dehydrated alfalfa meal				108
Sorghum silage	423	351	287	339
Feed cost per cwt. gain ($)	25.38	24.20	23.80	24.38
Dressing percent	60.9	61.6	60.4	61.1
Carcass grade score[2]	4.0	3 6	3.6	3 8
Live steer value per cwt. ($)[3]	21.58	22.14	22.03	21.79
Estimated daily carotene intake (mg.)	3.78	20.2		
Terminal vitamin A levels				
Plasma (mcg./100 ml.)	7.7	15.1		
Liver (mcg./gm. D.M.)	0.9	2.2		

[1] Two par.s salt and one part steamed bone meal.
[2] Numerical score: 1= Prime, 4= Choice, 7= Good, etc.
[3] Computed from carcass weight and current value, based on final live weight off test.

or two-fifths of the cottonseed meal; carcass grades were improved and live animal value was raised from $.21 to $.56 per cwt.

Symptoms of vitamin A deficiency were observed in calves of the basal lot near the end of the 163-day fattening period. These calves received only a small amount of carotene from the silage (calculated to be less than 4 mg. per head daily) in addition to the liver stores they possessed at the start of the trial. One calf became permanently blind, another showed the convulsive symptoms often observed in feed-lot cattle deficient in vitamin A. Several calves showed edematous swellings around the hocks, forelegs and brisket. Apparently as little as 1.0 lb. of alfalfa hay, supplying about 17 mg. carotene, was sufficient to meet the needs of calves over the 163-day feeding period since none of the calves of Lot 2 showed any evidence of a vitamin A deficiency. Additional amounts of carotene supplied by 3.0 lb. alfalfa hay or 2.5 lb. dehydrated alfalfa meal pellets (Lots 3 and 4) did not result in further increases in gain. Plasma vitamin A levels of calves of Lot 1 were very low at the end of the trial. Liver samples taken at slaughter from calves of Lots 1 and 2 revealed liver vitamin A stores which would be considered very low for both groups according to many authorities (6).

Three, more extensive fattening tests were conducted in which alfalfa hay replaced cottonseed meal at the one-fourth and one-half substitution levels, and dehydrated alfalfa meal pellets replaced cottonseed meal at the one-fourth, one-half and complete replacement levels. The results of the 1953-54 trial are given in Table 2. Blood vitamin A values taken at the end of the trial are also shown, as well as levels at slaughter

The results of the more extensive trial (Table 2) were similar to those observed in the first trial. Gains of steers in the basal lot were significantly less than those of the other lots in this test ($P<.05$). Again, symptoms of vitamin A deficiency appeared in calves of the basal group, similar to those observed on the same basal ration the previous year. Chemical analysis of silage used in this and the previous trial (as shown in Appendix Table I) revealed a very low content of carotene. With this as the only source of carotene, young calves were apparently not protected from a vitamin A deficiency over the 166-day fattening period. Increasing the amount of carotene by feeding dehydrated alfalfa or alfalfa hay gave a corresponding rise in plasma carotene and vitamin A to levels which would be considered satisfactory. Blood and liver vitamin A values obtained at the end of the trial were much lower for the basal than for any of the other lots. All calves appeared to have low liver vitamin A storage. Blood vitamin A levels of approximately 20 mcg./100 ml. have been considered "normal" in studies at this station (5).

Table 2.—Effect of Substituting Alfalfa Hay or Dehydrated Alfalfa Meal Pellets for Cottonseed Meal in Fattening Rations of Steer Calves. (Trial II. 1953-54, 166 days on test, 10 steers per lot[1])

Lot Number	1	2	3	4	5	6
Source of protein in supplement fed	C.S. Meal	3/4 CSM 1/4 Alf. hay	3/4 CSM 1/4 Dehyd. Alf. Meal	1/2 CSM 1/2 Alf. hay	1/2 CSM 1/2 Dehyd. Alf. Meal	Dehyd. Alf. Meal
Ave. daily gain (lb.)	1.89	1.95	2.05	2.10	2.13	2.12
Ave. daily ration (lb.)[2]						
Rolled milo	11.9	12.8	13.1	13.3	13.1	13.2
Cottonseed meal	1.8	1.4	1.4	.9	.9	
Alfalfa hay		1.2		2.3		
Dehyd. Alf. meal pellets			.9		1.7	3.3
Sorghum silage	8.6	8.5	8.6	6.8	8.6	8.5
2-1 mineral mix	.03	.03	.03	.03	.03	.03
Feed per cwt. gain (lb.)						
Rolled milo	631	659	639	633	617	624
Cottonseed meal	95	69	66	43	42	
Alfalfa hay		59		110		
Dehyd. Alf. meal pellets			44		79	157
Sorghum silage	457	436	418	324	403	401
Feed cost per cwt. gain ($)	21.24	21.92	21.44	20.65	20.93	21.75
Dressing percentage	60.93	61.22	61.58	61.38	61.17	61.01
Carcass grade score	4.0	4.2	3.7	3.4	3.7	3.7
Live steer value/cwt. ($)	22.32	22.67	23.01	23.09	22.71	22.83
Estimated carotene intake, mg./day	12.1	28.6	34.8	42.9	57.8	95.6
Terminal vitamin A levels						
Plasma (mcg./100 ml.)	13.5	23.2	23.3	27.4	29.4	33.1
Liver (mcg./gm. D.M.)	1.7	3.3	3.8	8.2	6.0	16.4

[1] One steer foundered in Lot 3 was removed from test and is not included in these data.
[2] One ounce calcium carbonate added to daily ration of Lots 1, 2 & 3.

It is apparent that for the 166-day fattening period, the carotene supplied by dehydrated alfalfa pellets (Lots 3, 5 & 6) or alfalfa hay (Lots 2 & 4) as supplements to milo and silage, were sufficient to achieve optimum gains and prevent symptoms of a vitamin A deficiency. The allowances for carotene for fattening steer calves of the weights used here according to Morrison (7) are approximately 30 to 45 mg. per head daily. Clearly, Lot 1 (basal) receiving only 12.1 mg. carotene per head daily from silage, was far below the recommended allowance.

There was little difference in milo required or feed cost per cwt. gain among the lots. Slightly lower dressing percentage and live steer value per cwt. was observed in the basal lot. Increasing the substitution level of alfalfa hay from one-fourth to one-half gave a slight improvement in gains. This was less apparent with the dehydrated product.

Calves of Lot 6, receiving all of their protein supplement as dehydrated alfalfa meal pellets, outgained the basal group, but did not differ significantly from the other lots getting lower levels of alfalfa hay or dehydrated alfalfa meal. Lots 5 and 6, which received one-half and all of their supplement as dehydrated alfalfa meal pellets, tended to have higher blood vitamin A levels than Lots 2 and 3. Lot 6 calves getting 3.5 lb. dehydrated alfalfa had the highest liver stores of any group. In previous studies at this station (8), supplementing a basal ration containing yellow corn, cottonseed meal and sorghum silage with a carotene concentrate did not improve steer performance.

A further series of trials followed, using the same basic design as shown for the second trial. Cottonseed meal was the only supplement fed Lot 1, whereas Lots 2 and 4 again received one-fourth and one-half of their supplemental protein from alfalfa hay, respectively. Lots 3, 5 and 6 received one-fourth, one-half and all of the supplemental protein from dehydrated alfalfa meal pellets.

Results of the two trials were similar, and thus the average results are shown in Table 3. In contrast to Trials I and II, no significant difference was observed in average daily gain. Calves fed the basal ration with no alfalfa gained fully as well as those fed 1 or 1.9 lb. of alfalfa hay, or .9, 1.8 and 3.5 lb. of dehydrated alfalfa meal pellets per head daily. Efficiency of feed conversion varied only slightly among the lots, and feed cost per cwt. gain was essentially the same, except for Lot 6 fed dehydrated alfalfa meal pellets only. The latter was due to the unfavorable price relationship between dehydrated alfalfa pellets and cottonseed meal when fed on a protein-equal basis. Further, there was little difference in dressing percentage or carcass grade among the lots.

An examination of the estimated daily carotene intake, and blood and liver vitamin A levels at the termination of Trials III and IV may explain why no differences between rations were observed. The silage fed in these trials ran considerably higher in carotene than the silage fed in the two previous tests (see Appendix Table I). Thus, steers of the basal lot received a daily intake of nearly 25 mg. carotene, which is only slightly below that suggested by Morrison (7) as necessary for fattening cattle of this age and weight. This greater intake of carotene for the basal lot is further reflected in higher blood and liver levels than observed in previous trials. No symptoms of a vitamin A deficiency were noted in Trial III. In Trial IV, several steers in the basal lot exhibited watering of the eyes and showed sufficient swelling of the brisket and forearm areas to be partially condemned and necessarily trimmed on the rail when slaughtered. The greater carotene intakes of the lots receiving either alfalfa hay or dehydrated alfalfa meal were reflected in higher blood and liver vitamin A levels, but in no greater gain over the basal. Had the fattening period progressed for a longer

Table 3.—Effect of Substituting Alfalfa Hay or Dehydrated Alfalfa Meal for Cottonseed Meal in Steer Fattening Rations. Ave. of Trials III & IV. 1954-55 and 1955-56, 165 days on test, 10 steers per lot in each trial)[1]

Lot Number	1	2	3	4	5	6
Source of protein in Supplement fed	C.S. Meal	3/4 CSM 1/4 Alf. hay	3/4 CSM 1/4 Dehyd. Alf. Meal	1/2 CSM 1/2 Alf. hay	1/2 CSM 1/2 Dehyd. Alf. Meal	Dehyd. Alfalfa Meal
Ave. daily gain (lb.)	2.19	2.20	2.26	2.19	2.22	2.15
Ave. daily ration (lb.)[2]						
Rolled milo	12.8	13.2	13.1	13.0	12.7	12.8
Cottonseed meal	1.6	1.2	1.2	.8	.8	
Alfalfa hay		1.0		1.9		
Dehyd. Alf. meal pellets			.9		1.8	3.5
Sorghum silage	11.2	10.4	10.2	10.0	10.1	9.6
2-1 mineral mix	.06	.07	.07	.07	.07	.06
Feed per cwt. gain (lb.)						
Milo	584	599	579	595	572	595
Cottonseed meal	73	55	56	37	37	
Alfalfa hay		43		86		
Dehyd. Alf. meal pellets			40		79	163
Sorghum silage	511	474	403	460	454	447
Feed cost per cwt. gain ($)	18.00	18.02	17.96	17.81	18.01	19.38
Dressing percentage	61.74	61.99	61.99	62.44	61.73	61.07
Carcass grade score	4.5	4.5	4.2	4.5	4.5	4.6
Live steer value/cwt. ($)	21.30	22.23	21.24	21.11	21.37	21.20
Estimated daily carotene (mg.)	24.7	41.4	45.3	58.3	62.8	96.2
Terminal vitamin A levels						
Plasma (mcg./100 ml.)	16.7	24.4	23.2	25.9	22.9	26.2
Liver (mcg./gm. D.M.)	2.6	4.7	5.5	5.1	10.8	8.1

[1] One steer removed from each of lots 2 and 4 for urinary calculi and are included in these data.
[2] One ounce calcium carbonate added to daily ration in Lots 1, 2 & 3.

time, or had the cattle used in this test been depleted of liver vitamin A stores at the start, symptoms of vitamin A deficiency might have occurred in the basal lot before the cattle left the feedlot.

Neither the carotene nor minerals contained in alfalfa were of benefit in this type of ration where vitamin A was adequate. This is further illustrated in Table 4. Here a comparison is made between the basal ration fed in Trial III and the same ration supplemented with either the carotene or alfalfa ash (minerals) contained in approximately 1.0 lb. of alfalfa hay. Average daily gains were essentially the same, indicating that the basal ration was adequate in carotene and minerals such as

Table 4.—Effect of Adding Carotene or Carotene Plus Alfalfa Ash to Cottonseed Meal Supplements for Fattening Steer Calves (Trial III. 1954-55, 163 days on test, 10 steers/lot)

Lot Number	1	7	8
Supplement fed	Cottonseed Meal	C. S. Meal + Carotene	C. S. Meal Carotene + Alf. Ash
Ave. daily gain (lb.)	2.29	2.22[1]	2.28
Ave. daily ration (lb.)			
Rolled milo	13.5	13.9	13.6
Cottonseed meal	1.6	1.6	1.6
Carotene[2]		15 mg.	15 mg.
Alfalfa ash[2]			.08
Sorghum silage	10.4	10.4	10.4
2-1 mineral mix	.06	.06	.06
Feed per cwt. gain (lb.)			
Rolled milo	592	612	588
Cottonseed meal	70	72	70
Sorghum silage	453	466	458
Feed cost per cwt. gain ($)[3]	19.34	21.46	21.34
Dressing percentage	61.73	62.83	62.44
Carcass grade score	4.9	4.3	5.2
Live steer value/cwt.	22.44	22.77	22.39
Estimated daily carotene intake (mg.)	29.1	44.1	44.1
Terinal vitamin A levels			
Plasma (mcg./100 ml.)	18.5	18.3	19.6
Liver (mcg./gm D.M.)	2.3	2.0	2.4

[1] One steer removed due to urinary calculi and is not included in these data.
[2] Fed to supply approximately the same carotene and ash as contained in 1.0 lb. of alfalfa hay.
[3] Includes equivalent cost of carotene concentrate and alfalfa ash.

contained in the ash fraction. Neither plasma vitamin A nor liver vitamin A appeared to be increased by further additions of carotene.

Alfalfa is known to possess a mineral fraction which has been shown at this station and elsewhere (9, 10) to improve the digestibility of corn cobs and cottonseed hulls by lambs, resulting in faster growth. Further, alfalfa is high in calcium, and the basal ration fed in the first trial may have been somewhat deficient in this element. Weber and associates at the Kansas station (11) have shown the need for additional calcium in rations for fattening beef calves.

The dehydrated alfalfa meal pellets proved to be slightly unpalatable when fed at the rate of 3.5 lbs. per steer daily—replacing all of the cottonseed meal. Judging by the performance of the cattle, dehydrated alfalfa and cottonseed meal were equal in value when fed at the same protein level, although it required nearly twice as much of the

dehydrated product to supply the same protein as provided by the cottonseed meal fed in these trials. The higher cost of the dehydrated product relative to cottonseed meal, when fed on a protein-equal basis, would make such substitution uneconomical if protein were the only consideration.

In these trials, dehydrated alfalfa meal was purchased from the dehydrating plants in June, when the price is normally lowest for the year. Even so, the pellets cost 98 percent more than alfalfa hay on a per ton basis. Thus, where hay can be produced locally and can be fed without excessive labor and waste, it would appear to be a more economical feed than dehydrated alfalfa meal. However, the blood and liver vitamin A values at the end of the feeding test indicate that the dehydrated product promoted slightly better vitamin A nutrition than did the hay. The dehydrated product ran somewhat higher in protein and carotene, and lower in fiber, than did the alfalfa hay used in these trials. In actual steer performance, when fed at the same protein level, there was little difference in the two products.

The failure to find an advantage for alfalfa in the last two trials, where carotene was not limiting, are not in agreement with results at Ohio (4), Purdue (3) or Nebraska (12). Workers at these stations using weathered timothy hay, corn cobs, or corn silage found a significant advantage from adding dehydrated alfalfa to the protein supplement; the response appeared to be greater than could be explained on the basis of its protein or energy content alone. In Kansas experiments (13) dehydrated alfalfa was added to a ration of wheat straw for wintering calves and gave greater gain performance than equivalent amounts of vitamin A. In Texas experiments (14), the substitution of dehydrated alfalfa for poor quality prairie hay in wintering rations gave increased performance, but the additional TDN from the dehydrated product may have been responsible for much of the boost in gain.

The apparent disagreement in results from adding alfalfa may be due to the differences in quality of roughage in the basal ration. Tillman *et al.* (10) have shown that the mineral or ash fraction of alfalfa will stimulate greater ration digestibility and growth in lambs fed cottonseed hulls, but has little effect when prairie hay is the roughage (15). Results of several trials with yearling steers at the Ft. Reno station (16) have indicated no advantage from adding dehydrated alfalfa to supplements where sorghum silage was the roughage. Thus, it is perhaps not surprising that rations containing milo, cottonseed meal and sorghum silage, as fed to calves in these trials, was apparently adequate in necessary nutrients for gain, with the exception of carotene.

From these tests, it appears that neither alfalfa hay nor dehydrated alfalfa meal were consistently beneficial when added to milo and sorgh-

um silage rations for steer calves. However, in two out of four trials the inclusion of at least 1.0 lb. of either product per steer daily was good "insurance" when fattening periods extended beyond 100 days. The need for feeding greater amounts than this would not appear to be necessary from the standpoint of steer performance—and would depend solely on the relative cost of the protein supplied. There appeared to be no additional factors in the dehydrated product not present in alfalfa hay. Replacing all of the cottonseed meal with dehydrated alfalfa meal resulted in slightly less gain and increased feed cost per cwt. gain in Trials III & IV.

Dehydrated alfalfa production in this area and the problems involved, especially those related to carotene preservation, have been well reviewed by workers at the Kansas station (17). The normal seasonal price for dehydrated alfalfa is lowest in the peak production season—May through July. At this time, the product can often be purchased quite economically compared with oil meals. However, much loss of carotene in storage under ordinary farm conditions occurs. An attempt was made in Trial III to better preserve the carotene by pelleting the dehydrated alfalfa with cottonseed meal in varying proportions. Research by Mitchell and Silker (18) and Burnius and Hellstrom (19) have indicated that dehydrated alfalfa meal, in mixtures with cottonseed meal, would retain a higher percentage of its initial carotene content during storage than would dehydrated alfalfa meal alone.

The results of carotene retention in the mixtures are shown in Appendix Table III. Also given are the losses of carotene from alfalfa hay during mow storage. The difference in initial carotene values for the dehydrated alfalfa, and the same product pelleted, is an indication of loss due to pelleting. Considerable heat is involved in this process, thus favoring destruction of carotene. Loose meal tended to lose less carotene than pelleted meal. During storage, the dehydrated alfalfa meal pelleted alone tended to lose about the same amount of carotene as combinations of dehydrated alfalfa and cottonseed meal. There was no consistent advantage from combining dehydrated alfalfa meal with cottonseed meal to slow down oxidative destruction of carotene.

It will also be noted that alfalfa hay, stored in bales in the mow, lost 56 percent of its original carotene content by December of the same year, and 61 percent by April of the following year. Such losses are part of the normal storage pattern. The severe carotene loss from storing either dehydrated alfalfa or alfalfa hay, plus the relatively low cost of synthetic vitamin A now available for commercial mixed feeds, makes it unlikely that feed sources of carotene are of as much importance as in the past.

Summary

Alfalfa hay was substituted for one-fourth and one-half of the cottonseed meal, and dehydrated alfalfa meal pellets for one-fourth, one-half and all of the cottonseed meal on an equal-protein basis in fattening rations for steer calves containing milo and sorghum silage. Such substitutions failed to consistently improve gains and feed efficiency and had little effect on carcass quality. In three of the four trials, there was some evidence of vitamin A deficiency in steers fed the basal ration with no alfalfa. Chemical analyses revealed that the silage was relatively low in carotene in trials where improvement from feeding alfalfa was noted. Vitamin A in the blood and liver of calves at the end of two out of four trials indicated a deficiency condition where no alfalfa was fed. In two trials where the silage was relatively high in carotene content, neither alfalfa hay, dehydrated alfalfa meal, nor the addition of carotene improved performance. The length of the feeding period appeared to be important, as no evidence of vitamin A deficiency on the basal ration appeared until after 100 days on feed. Fattening periods longer than 165-days might lead to serious deficiencies. For insurance purposes, it would appear that including 1.0 lb. per head daily of either form of alfalfa would be desirable.

Feed required per cwt. gain or feed costs were not consistently reduced when alfalfa hay or dehydrated alfalfa meal pellets replaced from one-fourth to one-half of the cottonseed meal. There was no evidence of "unidentified factors" in alfalfa under the conditions of this study. Adding alfalfa ash to the basal ration in one trial resulted in no improvement in steer performance. It is believed that the basal ration of rolled milo, cottonseed meal, sorghum silage and minerals, was adequate for fattening steer calves, with the exception of carotene. There was no evidence that the dehydrated product was superior to good quality alfalfa hay when fed at the same protein level.

Literature Cited

1. Burroughs, W., P. Gerlaugh and R. M. Bethke. 1948. Influence of alfalfa ash and water extraction of alfalfa upon roughage digestion in cattle. J. Animal Sci. 7:522.

2. Burroughs, W., P. Gerlaugh and R. M. Bethke. 1950. The influence of alfalfa hay and fractions of alfalfa hay upon the digestion of ground corn cobs. J. Animal Sci. 11:207.

3. Beeson, W. M. and T. W. Perry. 1952. Balancing the nutritional deficiencies of roughage for beef steers. J. Animal Sci. 11:501.

4. Klosterman, E. W., L. E. Kunkle, O. G. Bentley and W. Burroughs. 1953. Supplements to poor quality hay for fattening cattle. Ohio Agri. Expt. Sta. Res. Bul. 732.

5. Long, R. A., W. A. Van Arsdell, Robert MacVicar and O. B. Ross. 1952. Blood composition of normal beef cattle. Okla. Agri. Expt. Sta. Tech. Bul. T-43.

6. Guilbert, H. R. and G. H. Hart. 1935. Minimum vitamin A requirements with particular reference to cattle. J. Nutr. 10:409.

7. Morrison, Frank B. Feeds and Feeding. 22nd Ed. The Morrison Publishing Company, Ithaca, New York.

8. Pope, L. S., R. D. Humphrey, A. E. Darlow, V. G. Heller, O. B. Ross and R. A. Long. 1954. Beef cattle feeding investigations. Okla. Agri. Expt. Sta. Bul. B-428.

9. Chappel, C. F., R. J. Sirney, C. K. Whitehair and Robert MacVicar. 1952. Effect of minerals on the digestion of low quality roughage by sheep. J. Animal Sci. 11:758.

10. Tillman, A. D., R. J. Sirney and Robert MacVicar. 1954. The effect of alfalfa ash upon the digestibility and utilization of cottonseed hulls by sheep. J. Animal Sci. 13:726.

11. Weber, A. D., C. W. McCampbell, J. S. Hughes and W. J. Peterson. 1940. Calcium in the nutrition of the fattening calf. Kans. Agr. Expt. Sta. Tech. Bul. 51.

12. Baker, M. L., V. H. Arthaud and Ellis Ruby. 1947. Dehydrated alfalfa and urea as sources of supplementary proteins for fattening cattle. Nebr. Agri. Expt. Sta. Prog. Report 190.

13. Richardson, D., E. F. Smith and R. F. Cox. 1953. Supplementing wheat straw in the winter rations of beef calves. Kans. Agri. Expt. Sta. Cir. 297

14. Gossett, J. W. and J. K. Riggs. 1956. The effect of feeding dehydrated alfalfa leaf meal and trace minerals to growing beef calves fed poor quality prairie hay. J. Animal Sci. 15:840.

15. Tillman, A. D., C. F. Chappel, R. J. Sirny and Robert MacVicar. 1954. The effect of alfalfa ash upon the digestibility of prairie hay by sheep. J. Animal Sci. 13:417.

16. Pope, L. S., R. D. Humphrey, D. F. Stephens, L. E. Walters and V. G. Heller. 1958. Supplements to silage rations for fattening yearling steers. J. Animal Sci. (In press).

17. Schrenk, W. C., H. C. Mitchell, Ralph Silker, C. O. Grandfield, W. H. Honstead and R. G. Taecker. 1953. Dehydrated alfalfa. Kans. Agr. Expt. Sta. Bul. 356.

18. Mitchell, H. L. and R. E. Silker. 1950. Stability of carotene in alfalfa. Ind. Eng. and Chem. 42:2325.

19. Brunius, E. and V. Hellstrom. 1946. The stability of carotene in dehydrated alfalfa meal. Chem. Abs. 40:2541.

Appendix Table I.—Chemical Composition of Feeds (Percent as fed).

	Moisture	Ash	Crude Protein	Ether Extract	Crude Fiber	N-free Extract	Ca	P	Carotene (mg./lb.)[1]
Trial I									
Milo	11.16	1.52	11.50	3.70	1.50	70.62	.04	.12	----
Cottonseed meal	5.99	6.10	39.48	5.05	9.57	33.81	.18	.71	----
Alfalfa hay	8.94	9.21	15.97	1.15	30.68	34.05	.91	.15	16.67
Dehyd. Alf. pellets	8.28	9.72	18.38	4.16	15.21	44.25	1.66	.15	84.58
Sorghum silage	67.06	5.87	1.42	1.17	8.75	15.73	.11	.01	.44
Trial II									
Milo	15.22	1.16	10.77	2.25	1.57	69.03	.06	.20	----
Cottonseed meal	7.48	6.17	38.87	7.67	9.22	30.49	--	--	----
Alfalfa hay	8.68	9.54	16.23	3.42	26.11	34.07	--	--	14.50
Dehyd. Alf. pellets	9.24	9.64	21.67	4.24	17.37	38.05	--	--	25.30
Sorghum silage	68.34	2.12	1.75	1.45	6.88	19.06	.13	.04	1.40
Trials III & IV									
Milo	10.76	1.74	10.85	2.88	1.83	71.96	.06	.29	----
Cottonseed meal	7.60	6.73	40.65	4.76	12.38	27.88	.18	.84	----
Alfalfa hay	7.09	9.77	17.07	2.53	26.27	37.29	1.25	--	19.72
Dehyd. Alf. pellets	5.90	13.22	18.49	3.21	19.49	39.69	1.21	--	22.96
Sorghum silage	70.88	2.08	1.97	.99	5.40	18.69	.14	.05	2.25

[1] Represents an average of 3 samples taken during the trial, except for Trial I where only one sample was taken.

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Appendix Table II.—Feed Costs by Years (dollars per ton).

Feed	Trial Number		
	I	II	III & IV
Rolled milo	66.00	51.40	45.30
Cottonseed meal	106.00	66.00	70.50
Alfalfa hay	30.00	30.00	27.50
Dehydrated alfalfa pellets	72.00	52.00	48.50
Sorghum silage	10.00	8.00	8.00
2-1 mineral mix	48.33	38.60	43.33

Appendix Table III.—Carotene Loss by Periods for Dehydrated Alfalfa Meal, Loose, Pelleted and in Combination with Cottonseed Meal, and Alfalfa Hay During Storage.[1] (Trial III, 1954-55).

Date Analyzed	Dehydrated Alfalfa Meal (loose)		Dehydrated Alfalfa meal, (pelleted)		Combination, 33% CS meal 67% dehyd. alf.		Combination 59% CS meal 41% Dehyd. Alf.		Alfalfa hay in bales	
	Mg./lb.	% loss	Mg./lb.	% loss	Mg./lb.	% loss	Mg./lb.	% loss	Mg./lb.	Mg./lb.
July-1954	99.4	---	80.2	---	42.7	---	34.6	---	56.3	---
Sept.-1954	73.4	26.2	34.0	57.6	20.3	52.5	20.1	41.9	36.5	35.2
Nov.-1954	71.7	27.9	38.8	51.6	18.9	55.8	21.0	39.3	29.7	42.3
Dec.-1954	48.6	51.1	28.0	65.1	21.4	50.0	14.0	59.5	24.9	55.8
Feb.-1955	51.5	48.2	25.2	68.5	17.3	59.6	11.6	66.4	---	---
April-1955	---	---	30.1	62.5	20.8	51.4	11.3	67.4	22.1	60.8

[1] Representative samples were obtained from each product and analyzed for carotene.