period than those from the poorly-nourished dams. Calves from the high level dams produced heavier, larger scaled carcasses, required less time in the feedlot and were more efficient converters of feed than were the low level calves.

In the second experiment, the influence of pre-weaning plane of nutrition on the pre- and post-weaning performance of beef calves was studied. Results indicate that, while calves limited in nutrient intake early in life tend to compensate for this restriction by making rapid and efficient gains when returned to full feed, they would require a considerably longer feedlot period to fully compensate for the initial advantage obtained by calves full fed early in life. Carcasses from the creep fed calves were larger, had more ribeye area, less external fat cover, and graded higher than those from the early weaned calves.

Improving the Utilization of Milo for Fattening Calves: The Effect of Various Supplements[1]

Curtis W. Absher, Robert Totusek, Robert E. Renbarger and Eldon C. Nelson

Previous research at the Oklahoma Station has been directed toward improving the efficiency of milo (sorghum grain) for fattening calves, and a considerable amount of additional work is now in progress. Milo, on a chemical basis, appears to be equal in value to corn. However, feedlot comparisons in the Southwest have consistently shown milo to be 10 to 20 percent less efficient than corn. Even so, milo makes up a large portion of cattle fattening rations in Oklahoma and much of the Southwest because of its relative price advantage over other feeds. Therefore, any changes in milo rations that will improve milo utilization and feed efficiency will add considerably to the income derived from the feeding of milo to beef cattle.

Much of the previous work at the Oklahoma Station was concerned with the physical preparation of the milo grain. This appears a logical place to start to improve milo utilization because of the hard, flinty outer portion of the milo kernal. Although some improvement in milo utiilzation can be made through processing methods (see Feeders' Day Reports for 1964 and earlier years) milo is still inferior to corn in feed efficiency.

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[1] The urea used in this study was generously provided through the courtesy of Dr. L. E. Craig, John Deere Chemical Company, Tulsa, Oklahoma.

The two trials reported herein are of an exploratory nature and were designed to study the effect of various supplements and combinations of supplements on milo rations. Since the protein of milo is rather low in solubility (48 percent compared to 79 percent for corn in a recent comparison), it would seem logical to assume that a readily soluble protein might enhance milo utilization. Several protein supplements and a protein substitute which differ considerably in solubility were compared to cottonseed meal in these trials. Urea (a protein substitute) is very soluble, while soybean meal is more soluble, and fish meal is less soluble than cottonseed meal.

One of the consistent differences in chemical composition between corn and milo is in fat (ether extract) content, with corn averaging about 1 percent higher. The influence of 1 percent corn oil added to a milo ration was determined. The effect of adding a complex supplement containing 11 vitamins and 6 trace minerals to a milo ration which contained urea and corn oil, and of adding copper to a urea-containing milo ration, was also determined.

Trial 1 (Winter 1963-1964)

Materials and Methods

Eighty weanling Hereford steer calves with an average weight of 540 lbs. were obtained from the herds at the Fort Reno Livestock Research Station. The calves were divided on the basis of sire and weight into heavy and a light groups which averaged 582 and 498 lbs., respectively. Four calves by each of 10 sires in each weight group were randomly assigned to four treatment groups, making a total of 8 treatment groups or pens with 10 calves per pen.

The calves were all allowed access to the same ration for 28 days to allow them to adjust to the new environment and to become accustomed to self feeders. The starter ration contained 60 percent concentrates and 40 percent roughage. The feeding trial lasted 168 days, from November 6, 1963 to April 22, 1964. Two weights were taken of each steer after 16 hours without feed or water at the beginning and end of the experimental period and the average weights were used as the on-feed and off-feed weights.

The feeding trial was divided into three periods of 56 days each. Rations fed during the initial period contained 30 percent cottonseed hulls and 10 percent chopped alfalfa. The level of cottonseed hulls was reduced to 20 and 10 percent during the 2 subsequent periods, resulting in a 20 percent roughage ration during the finishing period. Milo was increased as cottonseed hulls were decreased, with adjustments in levels of cottonseed meal as necessary to keep the rations isonitrogenous (equal in crude protein). All other ration ingredients remained constant throughout the feeding trial. Salt was fed at a higher-than-usual level of 1 percent, and ammonium chloride was added at a level of 0.5 percent during the latter part of the feeding trial, in an attempt to minimize the incidence of urinary calculi. The rations were formulated to contain 12 percent crude protein and an analysis of samples of the rations indicated they contained approximately that amount.

Table 1 gives the composition of the four experimental rations for the final period. Ration A, the control ration, contained cottonseed meal as the supplemental protein source. Urea replaced cottonseed meal in Ration B, C, and D. Corn oil, at a level of 1 percent, was added to Rations C and D. All vitamins believed to be required by simple stomached animals, with the exception of vitamin A which was added to all rations, and 6 trace minerals were added to Ration D.

Three calves were lost from the trial, one due to urinary calculi, one due to chronic bloat, and one due to death from an unknown cause. This resulted in three incomplete sire groups. In order to maintain balance in the trial and to prevent biasing the results, the data from the remaining calves of the 3 incomplete sire groups were not included in the comparisons involving rate of gain and carcass traits. The feed efficiency comparisons necessarily included data from all calves. The experimental design, with numbers of calves involved in the rate of gain and carcass comparisons, is given in Table 2.

Table 1. Percentage Composition of Rations

Ration	A	B	C	D
Treatment	Cottonseed Meal	Urea	Urea Corn Oil	Urea Corn Oil Vitamins Trace Minerals
	%	%	%	%
Milo (finely ground)	65.5	72.5	71.25	70.25
Cottonseed meal	8.0	---	.25	.5
Cottonseed hulls	10.0	10.0	10.0	10.0
Alfalfa meal	10.0	10.0	10.0	10.0
Molasses	5.0	5.0	5.0	5.0
Bone meal	.5	.5	.5	.5
Salt (NaCl)	1.0	1.0	1.0	1.0
Urea	---	1.0	1.0	1.0
Corn oil	---	---	1.0	1.0
Vitamin mix[1]	---	---	---	.75
	100.0	100.0	100.0	100.0
Trace minerals[2]				½#/ton
Vitamin A supplement[3]	+	+	+	+
Aureomycin[4]	+	+	+	+

[1] Vitamin mix (per lb. of ration): Vitamin D, 100 I.U.; Vitamin E, 3 mg.; Vitamin K, 0.2 mg.; thiamine, 0.8 mg.; riboflavin, 0.8 mg.; panthothenic acid, 4.0 mg.; niacin, 5.0 mg.; pyridoxine, 1.0 mg.; biotin, .04 mg.; choline, 600 mg.; folacin, .25 mg.; Vitamin B_{12}, .004 mg.

[2] Trace minerals (per lb. of ration): Manganese, 4 mg.; iodine, 10 mcg.; copper, 1.5 mg.; zinc, 20 mg.; cobalt, .04 mg.; iron, 5 mg.

[3] Vitamin A was added to all rations at a level of 1500 I.U. per lb. of feed.

[4] Aureomycin was added to all rations at a level to result in an intake of approximately 75 mg. per calf daily during the latter part of the fattening period.

Table 2. Experimental Design

Ration	A		B		C		D Urea Corn Oil Vitamin-Trace Mineral Mix	
Treatment	Cottonseed Meal		Urea		Urea Corn Oil			
Pen numbers	1	5	2	6	3	7	4	8
No. calves per pen[1]	7	7	7	7	7	7	7	7
Ave. initial wt., lbs.	509	588	500	568	497	591	486	584
No. calves per treatment[1]	14		14		14		14	
Ave. initial wt., lbs.	549		534		544		535	

[1] Indicates number of calves which completed test in complete sire groups and which were included in data obtained from individual steers. Since calves were group fed by pens, all calves (77 completed the feeding trial) are necessarily represented in the feed data.

At the conclusion of the feeding trial the cattle were shipped to Arkansas City, Kansas, and slaughtered. Carcass information was obtained after a 48 hour chill.

Results and Discussion

The results of the feedlot and carcass phases of the experiment are tabulated in Tables 3 and 4, respectively. The steers on the control ration gained significantly faster than those on all other treatments. It appears that the addition of 1 percent urea to the ration depressed gain and that the addition of 1 percent corn oil alone did not overcome the detrimental effect of the urea. However, the addition of the vitamin-trace mineral mix plus 1 percent corn oil did overcome much of the depressing effect of urea. The difference in gain in favor of the corn oil-vitamin-trace mineral addition compared to urea alone is statistically significant, which indicates the difference is a real one. These results suggest that the milo-urea ration used in this experiment was deficient in nutrients contained in corn oil and/or the vitamin-trace mineral mix, even though the ration contained alfalfa, molasses and bonemeal.

The efficiency of feed conversion follows much the same pattern as rate of gain. Essentially the same amounts of the control ration (Ration A) and the ration containing corn oil, vitamins and trace minerals (Ration D) were required to produce 100 lbs. of gain, while slightly more of the other two rations (B and C) was required. Although differences are small and not statistically significant, the urea containing ration (Ra tion B) was the least efficient of the four.

Differences are noticeably small in all comparisons of the slaughter and carcass information. The quality grades and back fat averages followed the same pattern as the average daily gains. As expected, the average quality grade was lowest for carcass from the slowest gaining cattle. Similarly, carcasses from the fastest gaining cattle (control group) had the most fat around the rib eye, which significantly reduced the trimmed retail cut yield for this group. Differences in average dressing percentage are small and fail to follow any logical pattern, although the advantage of cattle on Ration C compared to Rations A and B is statistically significant.

Table 3. Feedlot Performance

Ration	A	B	C	D
Treatment	Cottonseed Meal	Urea	Urea Corn Oil	Urea Corn Oil Vitamin-Trace Mineral Mix
No. calves initially	20	20	20	20
No. calves completed trial	20	20	18	19
Ave. initial wt., lb.	549	534	544	535
Ave. final wt., lbs.	965	892	915	926
Ave. daily gain, lbs.[1]	2.48BCD[3]	2.14	2.21	2.32B[3]
Ave. daily feed intake[2]	21.2	19.5	19.9	20.0
Feed per cwt. gain, lbs.[2]	864	886	873	862

[1] Only data from calves which completed test in complete sire groups were included in gain average.
[2] Since calves were group fed by pens, all calves completing trial (77) are necessarily represented in feed data.
[3] Significantly greater than treatments indicated ($P < .05$) according to Duncan's New Multiple-range Test.

Table 4. Slaughter and Carcass Information

Ration	A	B	C	D
Treatment	Cottonseed Meal	Urea	Urea Corn Oil	Urea Corn Oil Vitamin-Trace Mineral Mix
Dressing %[1]	61.7	61.6	62.6AB[2]	62.0
Quality grade[3]	8.6	7.9	8.4	8.6
Rib eye area, sq. in.[4]	10.2	10.1	10.2	10 5
Fat over rib eye, in.[5]	.75	.60	.66	.62
Trimmed retail cut yield (% carcass wt.)[6]	47.3BCD[2]	49.1ACD[2]	48.4ABD[2]	48.6ABC[2]
Trimmed retail cut yield (% live wt.)[7]	29.2	30.3A[2]	30.3A[2]	30.1A[2]

[1] Calculated on basis of shrunk Ft. Reno live weight and chilled carcass weight.
[2] Significantly different than treatments indicated ($P < .05$) according to Duncan's New Multiple-range Test.
[3] USDA 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.
[4] Determined by measurement of tracings of ribeye.
[5] Average of three measurements determined on tracings of the ribeye.
[6] 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
[7] Trimmed retail cut yield as determined in footnote 6 multiplied by dressing %.

Decisions as to the value of using urea, corn oil, and a vitamin-trace mineral mix must be based on reasonable cost-return estimates. Table 5 contains cost-return estimates based on current feed and beef carcass prices. The value of 100 lbs. of gain was derived by adjusting current carcass prices in accordance with the average quality grade observed on each ration and multiplying by the dressing percent. The difference between the feed cost and value of 100 lbs. of gain represents the feeding-margin for each ration in this experiment under present price conditions.

Cost-return estimates were calculated two ways for Rations C and D. In one case the actual cost of corn oil was used. Since the response from feeding corn oil was small and probably represents its energy value rather than any nutritional factors peculiar to corn oil, the market cost of feed grade animal fat was used in the second cost estimate of the corn oil-containing rations.

Although the differences are small the urea containing rations with or without corn oil (B and C) produced the most favorable feeding margins in this trial (using cost of animal fat). The difference in the costs of Rations A and B is essentially the difference between the price of eight pounds of cottonsed meal and the combined price of seven lbs. of milo and one lb. of urea. The additional energy from corn oil improved the feeding margin by only $0.27 per cwt., while the addition of the vitamin-trace mineral mix decreased the feeding margin considerably regardless of the price of fat used. The margins for both Rations C and D are noticeably reduced when the actual cost of corn oil is used.

The fact that the complex supplement apparently improved rate of gain of calves on a milo-urea ration points out the need for additional research to identify the responsible nutrients and/or find supplements (protein or otherwise) which are cheaper sources of the needed nutrients than the supplements used in this experiment.

Table 5. Cost—Return Estimates and Feeding Margins

Ration	A	B	C	D
Treatment	Cottonseed Meal	Urea	Urea Corn Oil	Urea Corn Oil Vitamin-Trace Mineral Mix
Cost/cwt. feed[1]	$ 2.22	$ 2.07	$ 2.34[3] 2.13[4]	$ 2.57[3] 2.35[4]
Value/cwt. gain[2]	21.20	20.91	21.43	21.30
Feed cost/cwt. gain	19.18	18.34	20.43[3] 18.59[4]	22.15[3] 20.26[4]
Feeding margin/cwt. gain	2.02	2.57	1.00[3] 2.84[4]	0.85[3] 1.04[4]

[1] Feed prices: Ground milo, $2.25/cwt.; cottonseed meal, $4.50/cwt.; alfalfa meal, $1.85/cwt.; molasses, $1.27/cwt.; urea, $5,20/cwt.; cottonseed hulls, $20.00/ton; salt, $1.30/cwt.; bonemeal $5.60/cwt.; feed grade animal fat, $6.50/cwt.; corn oil, $2.05/gal. or $28.00/cwt.; trace mineral mix, $11.00/cwt; vitamin mix, $34.00/cwt.

[2] Based on prices of $34.00 for U.S. Good and $36.00 per cwt. for U.S. Choice carcass. The carcass values by treatment were: A, $34.36/cwt.; B, $33.94/cwt.; D, $34.35/cwt.

[3] Based on actual cost of corn oil

[4] Based on cost of feed-grade animal fat.

Another factor that should be considered is the spread in beef prices between grades since some depression in carcass grade can be expected when urea is used. In a situation of wide price spread between grades, the savings made on feed cost could be lost with a lower selling price for the cattle.

Trial 2 (Summer 1964)

Materials and Methods

Twelve pairs of twin calves were used in a series of pilot studies during the summer and early fall of 1964. The twins were selected on the basis of visual appraisal for maximum similarity in size, structure, shape of head and legs, and color pattern. Note the similarity in initial weight within twin pairs (Table 8).

The rations used are given in Table 6. All of the rations contained high levels of milo. Experimental differences in the rations are in the supplemental fraction, with nitrogen from different sources, and in one case, supplemental copper in a urea ration. The composition and nitrogen solubility of protein supplements are given in Table 7. Three pairs of twins were assigned to each of the following comparisons: Cottonseed meal vs. cottonseed meal + urea (Rations 1 vs. 2), cottonseed meal vs. fish meal (Rations 1 vs. 3), cottonseed meal vs. soybean meal (Rations 1 vs. 4), and urea vs. urea + copper (Rations 5 vs. 6).

Table 6. Percent Composition of Rations (Identical Twin Pilot Trials)[1]

	1 Cottonseed Meal	2 Cottonseed Meal + Urea	3 Fish Meal	4 Soybean Meal	5 Urea[2]	6 Urea+ Copper[3]
Milo (finely ground)	68.5	67.5	73.5	70.5	76.75	
Cottonseed hulls	10.0	10.0	10.0	10.0	10.0	
alfalfa pellets (17%)	10.0	10.0	10.0	10.0	10.0	
Dehydrated						
Salt	1.0	1.0	1.0	1.0	1.0	
Dicalcium phosphate	----	----	----	----	.75	
Deflourinated phosphate	.5	.5	.1	.5	-----	
Monsodium phosphate	----	----	.1	.1	-----	
Cottonseed meal ("old process")	10.0	10.0	----	----	-----	
Urea	----	1.0	----	----	1.5	
Fish meal (70%)	----	----	5.3	----	-----	
Soybean meal (50%)	----	----	----	7.9	-----	
Total	100.0	100.0	100.0	100.0	100.0	

[1] All rations contained an antiodidant, santoquin, and supplemental vitamin A to furnish 1,020 I.U. per lb. of feed.
[2] Ration 5 calculated to contain 13 ppm. copper.
[3] Cupric carbonate added to ration 6 at rate of 27.5 gm./ton. Resulting copper level estimated to be 30 ppm.

Table 7. Chemical Composition of Protein Supplements (%)

Supplement	Dry Matter	Crude Protein	Crude Fiber	N-Free Extract	Ether Extract	Ash	Ca	P	Nitrogen Solubility
Fish meal	92.89	77.7	0.4	0.2	9.2	12.5	2.81	2.13	28.5
Cottonseed meal	92.06	43.9	10.3	35.2	3.6	7.0	0.24	1.02	42.8
Soybean meal	92.13	50.9	7.4	31.4	2.4	8.1	0.49	0.69	73.6

In the case of each comparison, one calf of each pair of twins was assigned to a control ration, the other calf of the same pair to the test ration. The twins were randomly assigned to treatments and the individuals were positively identified with flexible plastic ear tags. They were individually fed in stanchion-type feeders twice daily. Approximately one hour was allowed for the calves to eat their feed before they were turned together in a paved lot with free access to water. Each member of a pair received the same amount of feed.

The feed was weighed at each feeding with the amount being regulated by the calf with the less vigorous appetite. Refused feed was not weighed back, but was re-fed the following feeding and the amount of new feed given was adjusted accordingly. An effort was made to feed no more than would be consumed to prevent accumulation of spoiled feed. Initial and final weights were taken after 18 hours without feed or water.

Results and Discussion

Feedlot performance of the twins is shown in Table 8. It will be noted that the average daily gains are generally low. This can be attributed to some degree to the size of the cattle involved but is primarily due to individual feeding in stanchions.

The addition of 1 percent urea to a milo ration containing cottonseed meal did not significantly improve rate of gain and feed efficiency (Rations 1 vs. 2). Apparently a readily soluble source of nitrogen such as urea does not improve the utilization of milo, which contains a slowly soluble protein, when added to a ration containing adequate supplemental protein from cottonseed meal.

Fish meal as the source of supplemental protein resulted in an increase of 21 percent in rate of gain and an improvement in feed efficiency of 16 percent compared to the cottonseed meal ration (Rations 1 vs. 3). It is interesting to note that the protein in fish meal is of low solubility. Perhaps fish meal supplies nutrients which are deficient in milo. Additional research on fish meal in milo rations is now in progress.

There was very little difference in performance of calves fed soybean meal vs. cottonseed meal as the supplemental protein (Rations 1

Table 8. Feedlot Performance (Identical Twin Pilot Trials)

Ration	Item: Comparison	No. Pairs of Twins	Days on Feed	Ave. Initial Wt., Lb.	Ave. Daily Gain, Lb.	Feed Per Cwt. Gain
1	Cottonseed Meal			395	1.41	735
	vs.	3	90			
2	Cottonseed meal + Urea			403	1.40	770
1	Cottonseed Meal			314	1.49	625
	vs.	3	95			
3	Fish Meal			306	1.80	526[1]
1	Cottonseed Meal			409	1.46	682
	vs.	3	95			
4	Soybean Meal			417	1.42	702
5	Urea			313	.84	890
	vs.	3	130			
6	Urea + Copper			314	1.00	735

[1] Significantly more efficient ($P < .05$) by use of Student's "T" test.

vs. 4). Soybean meal is usually considered to be a superior supplement for fattening rations, and contains a protein which is very readily soluble.

The addition of 17 ppm copper to a ration containing 1.5 percent urea as supplemental nitrogen improved rate of gain 19 percent and improved feed efficiency 17 percent (Rations 5 vs. 6). It has been theorized that the enzyme urease breaks down urea so rapidly that the nitrogen escapes in the form of ammonia before it can be incorporated into protein. It has been postulated that copper might inhibit the action of urease and thus improve urea utilization. How added copper functioned to improve performance in this trial is not known. Although all calves were drenched with phenothiazine before the feeding trial started, it is possible that copper functioned as an anthelmintic and thereby improved performance by reducing infestation of internal parasites.

Use of high levels of copper in the ration cannot be recommended at this time. Copper stores in the liver are increased, and since high levels of copper can be toxic to humans, such livers could be unfit for human consumption.

Summary

Group feeding trials with milo rations for fattening calves showed that:

(1) Replacement of cottonseed meal with urea resulted in a decreased rate of gain but decreased the feed cost of gain and improved the feeding margin.

(2) The addition of corn oil to a milo-urea ration did not greatly improve performance, but a complex vitamin-trace mineral plus corn oil improved the rate of gain of calves on a milo-urea ration.

Pilot trials with individually-fed identical twin calves fed high milo rations indicated that:

(1) Neither the addition of urea to a cottonseed meal ration nor the replacement of cottonseed meal with soybean meal was of benefit.

(2) Either the replacement of cottonseed meal with fish meal or the addition of copper to a urea ration improved rate and efficiency of gain.

The Relationship Of Animal Age To Lean, Fat And Bone In The Beef Carcass

R. L. Henrickson and R. L. Monroe

Previous beef carcass investigations pertaining to body composition have used animals that include a variation in age, breed, sex, grade, etc. Carcass studies have demonstrated the wide variation in fat composition from animals on a fattening ration. However, age and breed also have caused marked differences in carcass composition.

In general, many beef carcasses today carry more fat, both external and internal, than is desired by the consuming public. Recognition by those in human nutrition and the medical profession that excessive amounts of fat may be harmful to the human body, has caused widespread interest in the fat problem. The role of animal fat in the diet has not been clearly delineated; however, it does appear that less fat is required than was formerly provided in good quality meat. Since removal of excess fat is one of the major problems confronting the beef industry, it is appropriate to determine tissue development during the growth period.

Procedure

Thirty-six Hereford heifers were used to investigate the effect of advancing age on the changes in carcass tissues. The heifers at six months of age were randomly assigned to six age groups. During the period from 6 months until the first group was slaughtered, the calves nursed their dams and had free access to a creep feeder.