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CATTLEMEN'S DAY

DEPARTMENT OF ANIMAL SCIENCE & INDUSTRY
KANSAS AGRICULTURAL EXPERIMENT STATION
KANSAS STATE UNIVERSITY, MANHATTAN
FLOYD W. SMITH, DIRECTOR

59th Annual
CATTLEMEN'S DAY

Friday, May 5, 1972

FRIDAY, MAY 5, 1972

8:00 a.m. Weber Hall Arena
Registration—Exhibits
(Coffee and donuts served)

10:00 a.m. Weber Hall Arena
Dr. Don L. Good, Head, Department of Animal Science and Industry, KSU, presiding

- Welcome
  Glenn H. Beck, Vice President for Agriculture, Kansas State University
- Organic Acid Treatment of Grain
  Dr. Keith Bolsen
- Feeding Value of Different Varieties of Sorghum Grain
  Dr. Jack Riley
- New Approach to Polioencephalomalacia
  Dr. B. E. Brent
- Feedlot Bullers
  Dr. Guy H. Kiracofe
- Performance and Carcass Characteristics of Different Cattle Types
  Dr. Michael E. Dikeman
- Central Bull Testing
  Herman W. Westmeyer, Extension Beef Specialist
- Remarks
  Mr. Kalo Hineman, President, Kansas Livestock Association, Dighton, Kansas

12 noon Weber Hall
Lunch: Roast beef

1:00 p.m. Weber Hall

- Introduction of Guest Speaker
  Dr. Don L. Good, Head, Department of Animal Science and Industry
- Recent Developments in the Cattle Industry in Southeastern United States
  John Trotman, President, American National Cattlemen's Association

John Trotman, president of the American National Cattlemen's Association, is a distinguished stockman well qualified to discuss "Recent Developments in the Cattle Industry in Southeastern United States." A graduate of Auburn University, Trotman is a cattle producer and feeder in Montgomery, Alabama and president of the Trotman Cattle Buyers Association. He is district chairman of the Intermediate Credit Bank of New Orleans, chairman of the Montgomery Production Credit Association board, and vice-president of the Southeastern Livestock Exposition. Before being elected president of the American National Cattlemen's Association, Trotman had served as regional vice-president and first vice-president. He also was president of both the Montgomery County (Ala.) Cattlemen's Association and the Alabama Cattlemen's Association, the largest state association in the U.S. Both Kansas cattlemen and owners and managers of Kansas agri-business firms should benefit from Mr. Trotman's talk.

2:00 p.m. Beef Cattle Research Center
(about 2 miles north, at end of College Avenue)

6:30 p.m. Kansas State Union Ballroom
Block and Bridle Banquet for parents and visiting stockmen

FOR THE LADIES

Thursday, May 4, 1972

6:30 p.m. Bluemont Room, KSU Union
Kansas Cow Belles Dinner
Reservations by May 2 to:
Mrs. Don L. Good
2027 Sunnymeade Road
Manhattan, Kansas 66502

Friday, May 5, 1972

10:00 a.m. Weber Hall, Staff Memorial Library
Coffee for visiting ladies

11:00 a.m. Weber Hall, Room 107
Program "Meat and the Consumer" (Prices, Additives, Labels, Health Issues)
Dr. David Schafer, Extension Meats Specialist, Department of Animal Science and Industry, KSU

C O N T E N T S

Effect of Organic Acids on the Preservation and Feeding Value of Reconstituted Milo[1]

K. K. Bolsen, O. J. Cox and C. L. Drake

The use of high moisture grain in beef cattle rations has increased during the past several years. It has improved feed efficiency of high energy rations five to 20 percent in previous research. Non-nutritional advantages of high moisture grain include: (1) earlier harvest to lengthen the harvest season and/or free land for other uses; (2) fewer field losses from shattering lodging, wind and early frost and (3) no artificial drying.

Structures suitable for storing high moisture grain are air-tight, concrete stave, trench and bunker silos. The storing and handling of high moisture grain in conventional grain storage facilities could add new dimensions to its use as a feed for livestock. Laboratory tests have shown that volatile fatty acids (formic, acetic, propionic and butyric) have fungicidal properties and prevent mold growth in high moisture feeds. The organic acids also have nutritional value to ruminants. They occur naturally during digestion and supply 40 to 70 percent of the energy used by beef cattle.

The objectives of this trial were to evaluate the effectiveness of an organic acid mixture[2] as a preservative for reconstituted milo and to determine the feeding value of the preserved grain.

Experimental

One hundred yearling steers of Angus, Hereford and Angus x Hereford breeding averaging 811 pounds were used in a feedlot trial beginning June 30, 1971. Three pens of five steers (group-fed) and five individually-fed steers were randomly assigned to each of five treatment groups.

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[1]Organic acids and financial support provided by Celanese Chemical Company, Corpus Christi, Texas.

[2]Organic acid mixture (trade name - ChemStor) contained 60% acetic and 40% propionic acids.

The following milo treatments were compared: (1) steam-flaked; (2) reconstituted whole, stored in an air-tight silo; (3) reconstituted whole, treated with the organic acid mixture, stored in a concrete stave silo; (4) the same as treatment 3 but stored in a metal grain bin and (5) reconstituted whole, then rolled and stored in a concrete stave silo. The same source of elevator-run, red milo was used for all milo treatments.

Steam-flaked milo was prepared once a week by subjecting the grain to steam in an over-sized steam chamber for 40 minutes at 210°F under atmospheric pressure and then rolling through a Ross mill with no tolerance on the rolls.

The reconstituted milo contained approximately 29 percent moisture; the organic acid mixture was applied at 30 pounds per ton of wet grain (2.11 percent on a dry grain basis). The acid, a clear, colorless liquid, was sprayed on the grain as it passed through an auger. Grain stored whole was rolled prior to feeding.

The initial rations contained 53 percent of the appropriate milo, 43 percent corn silage and four percent supplement (table 1) on a dry matter basis. Corn silage was gradually replaced with grain the first 17 days of the feeding period until final rations were 81 percent milo, 15 percent corn silage and four percent supplement on a dry matter basis. Dry matter content of the rations was 77.2, 70.4, 69.1, 70.8 and 70.3 percent for treatments 1-5, respectively. All rations were mixed and fed twice daily. Each steer was implanted with 30 mg of stilbestrol. The group-fed steers were confined to 15 x 30 foot non-sheltered, concrete pens; individually-fed steers were housed in 6 x 24 foot sheltered, concrete pens. Full weights were taken on two consecutive days at the beginning and end of the 112-day finishing trial. Final live weight was adjusted to a 60.9 percent dress and feedlot performance calculated on this basis.

Results and Discussion

Feedlot performance and carcass data for the group-fed steers are presented in table 2. Steers fed reconstituted milo stored in an air-tight silo (treatment 2) and reconstituted milo treated with organic acid (treatments 3 and 4) were similar in rate of gain, feed consumption and feed required per pound of gain. Steers fed steam-flaked and reconstituted, rolled milo (treatments 1 and 5, respectively) gained less ($P < .05$) than steers receiving the other rations. Daily feed consumption was lowest ($P < .05$) for steers fed steam-flaked grain. Steam-flaking on a weekly basis apparently reduced acceptability of the ration. In previous research at this station (1971 Cattlemen's Day - Bulletin 546), steers fed milo steam-flaked on a daily basis consumed nearly the same as steers fed reconstituted milo. In the trial reported herein, feed efficiency was significantly ($P<.05$) influenced by treatment. Steers receiving the reconstituted, rolled milo required an average of 0.63 pound more feed per pound of gain than those receiving the other four rations. No significant differences were obtained in carcass traits; however, dressing percentage tended to be higher for steers receiving the reconstituted milo treated with organic acid (treatments 3 and 4).

Individually-fed steers responded to the grain treatments (table 3) similar to group-fed steers. Steam-flaked and reconstituted, rolled milo resulted in lower gain ($P<.05$) and lower feed consumption than the other three rations.

Most of the reconstituted milo treated with the organic acid mixture was free of mold or spoilage. However, some heating and deterioration occurred in grain within three or four inches of the storage walls. This was probably from moisture migrating from the grain to the walls and a subsequent neutralization of the organic acids. Lining the storage facility with polyethylene should prevent this type of spoilage.

Table 1. Composition of the supplements.

Ingredient	% (dry matter basis)
Rolled milo	10.9
Soybean meal	45.5
Urea	10.7
Salt	12.5
Limestone	18.4
Trace minerals	0.5
Vitamin A[a]	0.7
Chlortetracycline[b]	0.8

[a]Formulated to supply 30,000 IU per steer per day.

[b]Formulated to supply 70 mg per steer per day.

Table 2. Performance and carcass data of the group-fed steers.

Item	Milo treatment 1: Steam-flaked	2: Reconstituted, Air-tight silo	3: Reconstituted, Organic acid treated, concrete silo	4: Reconstituted, Organic acid treated, metal bin	5: Reconstituted, Rolled, concrete silo
No. steers	15	15	15	15	15
Initial wt., lbs.	786	801	812	806	822
Final wt., lbs.	1120	1156	1165	1178	1153
Avg. daily gain, lbs.	$2.98^{a,b}$	3.18^{c}	$3.16^{b,c}$	3.32^{c}	2.94^{a}
Avg. daily feed, lbs.^{d}	18.9^{a}	20.6^{b}	$21.5^{b,c}$	22.1^{c}	$21.2^{b,c}$
Feed/lb. gain, lbs.	6.34	$6.48^{a,b}$	6.80^{b}	$6.66^{a,b}$	7.21^{c}
Hot carcass wt., lbs.	682	704	709	718	702
Dressing percentage	60.2	60.7	60.8	61.3	60.4
Quality grade^{e}	10.1	9.9	10.1	10.5	9.7
Yield grade	3.28	3.35	3.56	3.56	3.57
Fat, 12th rib, in.	0.64	0.61	0.56	0.64	0.59

[a,b,c]Means in the same row with different superscripts differ significantly (P .05).

[d]Dry matter basis.

[e]Quality grade assigned, 10 - low Choice, 11 - average Choice.

Table 3 . Performance and carcass data of the individually-fed steers.

	Milo treatment				
	1	2	3	4	5
		Reconstituted			
Item	Steam-flaked	Air-tight silo	Organic acid treated, concrete silo	Organic acid treated, metal bin	Rolled, concrete silo
No. steers	5	5	5	5	5
Initial wt., lbs.	858	841	853	807	785
Final wt., lbs.	1157	1209	1165	1150	1064
Avg. daily gain, lbs.	2.67[a]	3.28[b]	2.78[a,b]	3.07[a,b]	2.49[a]
Avg. daily feed, lbs.[c]	17.2	21.4	20.0	20.7	18.3
Feed/lb. gain, lbs.	6.51	6.56	7.66	6.73	7.37
Hot carcass wt., lbs.	704	736	709	700	648
Dressing percentage	60.2	60.0	61.5	61.8	60.4
Quality grade[d]	9.4	9.4	9.2	9.8	9.6
Yield grade	3.21	3.67	3.71	4.01	3.57
Fat, 12th rib, inc.	0.57	0.68	0.67	0.71	0.66

[a,b]Means in the same row with different superscripts differ significantly (P .05).

[c]Dry matter basis.

[d]Quality grade assigned, 10 - low Choice, 11 - average choice.

Effect of Maturity Stage on the Nutritive Value of Native Grass Hay

M. R. Rao, L. H. Harbers, A. M. Latschar, and E. F. Smith

The evaluation of pastures by esophageally fistulated steers requires artificial rumen techniques to determine digestibilities of grasses. To develop a regression curve between data obtained by an artificial rumen and those from a grazing animal, we conducted a series of metabolism studies and artificial rumen trials using native prairie hay from the Flint Hill area cut at three maturity stages.

Twelve Angus steers (average weight, 642 lbs.) were fed ad libitum quantities of hays harvested in June, July, and September in a factorially designed experiment. Sodium chloride and water were available free choice. Animals were maintained on each hay 14 days before being put into metabolism crates. Then a 7-day collection period followed a 7-day adjustment interval.

Results and Discussion

Compositions of the three hays are given in table 4. Nutrients that decreased with maturity were crude protein, neutral detergent fiber, ash-free neutral detergent fiber, acid detergent fiber, and calcium. Cellulose and lignin increased with maturity, while hemicellulose, crude fiber, and nitrogen free extractives remained equivocal.

Digestibility coefficients (as %) are presented in table 5. Nutrient digestibilities were generally highest for June hay, lowest for September. With certain exceptions (nitrogen-free extractives, hemicellulose, calcium) September hay was poorer than July hay. Steers maintained a positive nitrogen balance on June and July samples, but not on the September hay.

Calcium and phosphorous balances (table 6) cannot be interpreted as nitrogen balance is because of different metabolic pathways; however, Ca & P balances indicate when additional mineral supplementation is needed. Calcium equilibrium was maintained except on September hay. Excretion was relatively constant so maintenance of equilibrium was related to intake. The steers were in negative phosphorous balance on June and September hays but maintained phosphorous equilibrium on July hay. Phosphorous was below the animals' requirement for all hays, so all should produce a negative phosphorous balance, but that was not the case. The negative phosphorous balances may be partially explained by the differences in Ca:P ratio. Positive phosphorous balance was maintained only with July hay when the Ca:P ratio was 2.75:1. Phosphorous ratios seem to be more important than phosphorous level. An excess of either calcium or phosphorous decreases absorption of the other because insoluble tricalcium phosphate is formed. Other minerals, not evaluated, such as magnesium, manganese, iron, and zinc also interfere with phosphorous absorption.

Average daily dry matter intake was 13.30, 11.83, and 10.07 lbs., on June, July, and September hay, respectively. Animals maintained positive nitrogen balance on June and July hays even though calculated digestible protein values were low (table 6).

Intake is usually lower in cattle confined to metabolism stalls than those penned or in a pasture. Increasing daily intake in stalls likely would not change digestion coefficients.

Table 4 . Nutrient composition (dry matter) of native hay cut in indicated month.

Nutrient	Hay Cut		
	June	July	September
Dry matter, %	94.70	94.83	94.93
Crude protein, %	5.52	4.50	3.43
Crude fiber, %	32.98	36.21	34.69
Ether extract, %	1.99	1.48	1.68
Ash, %	6.46	6.40	7.68
Nitrogen-free extract, %	47.74	46.16	47.43
Neutral detergent fiber, %	79.06	78.12	72.03
Ash free neutral detergent fiber, %	78.02	75.43	71.24
Acid detergent fiber, %	65.00	54.77	54.48
Organic matter, %	88.24	88.33	87.25
*Cellulose, %	47.69	48.23	51.09
*Hemicellulose, %	34.50	33.86	34.66
*Lignin, %	10.78	10.17	12.45
Calcium, %	0.420	0.289	0.359
Phosphorous, %	0.102	0.105	0.090
Ca:P ratio	4.19	2.75	3.98

*Expressed as percent of cell wall.

Table 5. Digestible nutrient content and nutritive value index of native hays cut at three maturity stages.

Constituent	Hay Cut		
	June	July	September
Dry matter, %	62.61	51.84	51.00
Organic matter, %	60.15	50.27	51.53
Crude protein, %	2.44	2.01	1.12
Crude fiber, %	23.60	23.66	21.04
Ether extract, %	.81	.58	.84
Nitrogen free extract, %	33.90	27.08	27.42
TDN, % (as fed)	58.44	51.24	48.72
TDN, % (dry)	61.72	54.04	51.33
Nutritive value index (dry)*	43.48	35.05	28.35

*Standard forage value = 70.00

Table 6. Nitrogen, calcium, and phosphorous balances and nutrient digestibilities of hays fed to steers.

Constituent	Hay Cut		
	June	July	September
Dry matter, %	66.11	54.67	53.73
Organic matter, %	68.17	56.85	59.06
Crude protein, %	44.27	44.60	32.69
Crude fiber, %	71.55	65.34	60.66
Ether extract, %	40.94	39.57	49.73
Nitrogen free extract, %	71.02	58.67	57.82
Digestible energy, %	65.91	56.72	52.04
Neutral detergent fiber, %	71.56	59.05	53.97
Acid detergent fiber, %			
Cellulose, %	71.05	60.59	63.94
Hemicellulose, %	77.23	69.27	69.18
Daily Ca intake, gm.	21.50	15.54	13.60
Daily fecal Ca, gm.	17.40	15.17	15.69
Daily urinary Ca, gm.	.07	.05	.07
Daily Ca balance, gm.	4.07	00.32	-2.16
Daily P intake, gm.	6.05	5.73	3.31
Daily fecal P, gm.	11.56	4.68	3.96
Daily urinary P, gm.	.02	01	.01
Daily P balance, gm.	-5.53	1.07	-0.66
Daily N intake, gm.	52.79	39.97	25.51
Daily fecal N, gm.	27.32	24.65	19.16
Daily N absorbed, gm.	25.47	15.32	6.75
Daily Urinary N, gm.	14.14	7.67	7.01
Daily N retained, gm.	11.24	6.66	-0.26
N retained of absorbed, %	44.10	50.00	Negative

Voluntary Intake of Cattle on Range: Esophageal and Hand Clipped Forage Samples Compared

M. R. Rao, L. H. Harbers, and E. F. Smith

To determine the nutritional value of an animal's diet, it is necessary to know the amount of each kind of feed consumed and its digestibility. A problem in range and pasture nutrition is accurate assessment of chemical and botanical composition of diets. Little detailed information on nutritive value of range and pasture forage is available.

Esophageal fistulae in grazing animals permit dietary samples to be taken and more accurate measurements of nutritive value of the forages consumed. Diet samples of animals grazing Flint Hill range have not been studied.

Reported here are: (1) an evaluation of esophageal samples, (2) total fecal output, (3) dry matter and nutrient intake, and (4) *in vitro* dry matter digestibility of esophageal samples.

Experimental Procedure

Eight 8-month-old Holstein steers weighing 550 pounds were used. Two each were allotted at random to four pastures of approximately 60 acres each. They were tamed and managed carefully for easy handling during sample collection. The steers were fitted with cannulae three months before the experiment started, and were trained to carry fecal collection bags.

Five digestion trials were run during June, July, August, September, and October, 1971. Total feces were collected for 48 hours before the esophageal collection. Animals were fasted overnight and esophageal samples were collected the next morning, transferred to a deep freezer, and stored until used.

Esophageal and feces samples were analyzed for dry matter, organic matter, ether extract, ash, crude fiber, and Kjeldahl nitrogen by the AOAC (1965) methods. Cell wall constituents were determined by procedures Goering and Van Soest described (Agriculture Handbook 379, USDA, 1969).

Discussion

The proximate analyses of esophageal and hand clipped forage samples are given in table 7 and cell wall constituents in table 8. The average crude protein content was higher in esophageal samples during all five months (6.94 vs. 4.29%), as was ash content (10.12 vs. 8.24%). Average crude fiber and NFE were lower in esophageal samples (28.22 vs. 30.69%; 42.96 vs. 44.96%). Considerable experimental evidence confirms that the plants the animals select influences crude protein and crude fiber content consumed.

Cell wall constituents were lower in esophageal samples than in hand clipped samples (48.49 vs 54.66). The *in vitro* dry matter and organic matter disappearance (IVDMD and IVOMD) data for esophageal and hand clipped forage samples are in table 9. Percentages of IVDMD and IVOMD were higher in esophageal samples than in hand clipped samples (47.32 vs 44.16 and 48.49 vs 46.34).

Animals on pasture selected diets more digestible than hand clipped forage samples. The forage the animals selected was higher in crude protein but lower in crude fiber, NFE, and acid detergent fiber. Studies to estimate total intake during different months are continuing.

Table 7. Chemical composition percentages of pasture samples obtained by esophageal or hand sampling techniques.

Time	Type*	Ash	Crude protein	Crude fiber	Nitrogen-free extract	Ether extract	Dry matter	Organic matter
June	ES	8.32	8.84	28.53	44.00	2.36	92.07	83.75
	HC	7.61	5.84	28.99	45.71	2.47	90.63	83.02
July	ES	9.58	8.35	30.13	40.96	2.39	91.43	81.85
	HC	8.06	5.36	30.19	42.62	2.33	88.57	80.50
August	ES	10.22	6.23	30.98	42.04	1.982	91.46	81.24
	HC	8.66	4.01	30.91	45.75	2.29	91.64	82.97
September	ES	11.87	6.16	24.88	44.56	3.46	90.94	79.07
	HC	8.54	3.91	29.74	44.19	2.36	88.73	80.18
October	ES	10.62	5.12	26.76	43.27	2.41	89.39	78.76
	HC	8.25	2.37	33.65	46.57	1.88	92.79	84.48

*ES = esophageal sample, HC = hand clipped sample.

Table 8. Cell wall constituents of pasture samples obtained by esophageal or hand sampling techniques.

Time	Type*	Percentage of organic matter: Neutral detergent fiber	Neutral** detergent fiber	Acid detergent fiber	% of cell wall: Hemicellulose	Cellulose	Lignin
June	ES	83.23	80.37	46.69	39.58	46.88	8.11
	HC	76.45	73.77	51.14	33.20	50.62	9.16
July	ES	87.82	84.40	47.75	39.33	54.63	7.76
	HC	80.48	77.70	52.87	34.29	48.94	8.76
August	ES	84.64	81.21	51.17	32.32	49.01	10.80
	HC	78.81	76.16	53.06	32.64	48.99	9.29
September	ES	78.75	72.36	45.64	31.04	48.17	12.96
	HC	80.93	77.16	56.54	29.70	49.44	10.09
October	ES	81.50	77.64	51.23	28.33	48.68	9.07
	HC	85.75	82.35	59.71	30.34	49.72	10.12

*ES = esophageal sample, HC = hand clipped sample.

**Ash free basis.

Table 9. In *vitro* dry matter and organic matter disappearance (IVDMD and IVOMD) of esophageal and hand clipped forage samples.

Nutrients	Type	June	July	August	September	October
IVDMD	ES	50.44	52.87	42.04	45.27	40.79
	HC	47.34	48.48	41.65	42.03	38.82
IVOMD	ES	51.79	53.78	44.45	44.79	43.61
	HC	50.11	50.24	42.65	43.02	42.01

ES = esophageal samples, HC = hand clipped samples.

Nutritive Value of Eight Hybrid Sorghum Grains and Three Hybrid Corns Compared in All-concentrate Rations

Part I
Hybrid Sorghum and Corn Characteristics and Methods Used to Nutritionally Evaluate Them

R. L. McCollough

Introduction

In 1971, Kansas produced 234 million bushels of sorghum grain worth $217,000,000, second only to Texas. Most of it is used as an energy source in livestock rations. Since the introduction of hybrid sorghum grain in 1956, yield has increased 25%.

Many genetic characteristics of parent varieties can be combined to produce a desirable hybrid. Some grain characteristics under genetic control include: white or yellow endosperm; red, white, or brown pericarp; all waxy (100% amylopectin) or normal (25% amylose, 75% amylopectin) starch in the endosperm; and corneous or floury endosperm. With different combinations of those genetic characteristics, different hybrids may vary markably from one another on pericarp color and endosperm characteristics. Presently, yield per acre is the main criterion used to evaluate hybrids, so the effect of genetic characteristics on nutritional value of hybrid grain fed to livestock needs to be studied. This project compared the nutritional value of genetically different hybrid sorghums and corns fed to steers.

Material and Methods

During the spring of 1970, eight hybrid sorghums and three hybrid corns were planted under similar conditions of fertilization, planting, and harvesting on irrigated river bottom ground. About 12 acres of each hybrid were planted except that shortage of seed of Funk 3135 (2/3 waxy) limited it to 2 acres. About 1000 bushels of each other hybrid was harvested and stored separately until fed. Descriptive characteristics of each are given in table 10.

Grains were dry rolled and incorporated into all-concentrate rations formulated to meet minimum NRC requirements for both the feeding and digestion trials (table 11). Each steer received 1 pound per head per day of soybean meal (44% crude protein) added during the last 56 days in an unsuccessful attempt to improve gains. Proximate analysis and gross energy data are shown in table 12 for the hybrids; in table 13 for the rations. Mineral composition of the hybrids is given in table 14.

Table 12 shows that crude protein of BR-1023 was the highest (14.08%). Although ether extract was the highest for high oil corn, high lysine corn had 5.65 compared with 3.66% for regular corn. NFE was lowest for BR-1023 (78.27%) and high oil corn (78.13%); highest for E-57 (83.47%). Gross energy was highest for high oil corn (4.742 kcal/gm); BR-1023 with 4.734 kcal/gm was next, while regular corn and 2/3 waxy sorghum had the lowest, 4.439 and 4.406 kcal/gm, respectively. There was essentially no difference in mineral contents of hybrids (table 14).

Yield data (bushels/acre) were collected for each hybrid. The only difference in yield among hybrids was high lysine corn yielding significantly less than other corns.

The nutritional values of 11 different hybrid grains were studied during the winter of 1970-1971. Angus steers (139 head averaging 728 pounds) were randomly allotted by weight to nine treatments, 15 head per treatment. We had only enough high lysine corn and 2/3 waxy sorghum grain to feed two steers per treatment in individually sheltered lots. With the other nine grains, 10 head were group fed in 2 pens of 5 each in nonsheltered concrete lots. Five head per treatment were individually fed in concrete, sheltered lots open to the south.

Feedlot performance data collected from 15 head per treatment are summarized in Part II. The digestion data collected from the individually fed cattle are discussed in Part III.

In vitro gas production by Diazyme 160 (Miles Laboratories) and rumen fluid was measured for each of 11 hybrids grain (3 corns and 8 sorghums). We attempted to correlate feed efficiency and digestible energy with *in vitro* gas production. In no case were the regression values significant.

Table 10. Description of eight hybrid sorghum grains and three hybrid corns fed winter, 1970-1971.

Hybrid	Abbrev. in text	Pericarp color	Endosperm description
Funk's G-766W[a]	(G-766W)	White	Yellow
Acco R-109[a]	(R-109)	Red bronze	Yellow
DeKalb E-57[a]	(E-57)	Red	Yellow
Northrup King 222[a]	(NK-222)	Red bronze	Yellow
Nc+ RS-671	(RS-671)	Red	White
Acco 1023	(BR-1023)	Dark red	White (Bird Resistant)
Asgrow Jumbo-C	(Jumbo-C)	Red	White
Funk's 2438	(High oil corn)	Yellow corn	High oil corn
Hulting X9770	(Regular corn)	Yellow corn	Yellow dent corn
Funk's 3135	(2/3 waxy)	Red	White 2/3 waxy[b]
Funk's 24554	(High lysine corn)	Yellow corn	High Lysine opaque 2 corn (Floury endo-sperm)

[a]Used in previous trials.

[b]Waxy refers to the amylopectic type of starch; 2/3 of the contribution of waxy gene from waxy parents.

Table 11. Composition of all-concentrate ration, 1970-1971 feeding trial.

Ingredients	% of ration as fed
Sorghum grain or corn	97.74
Dicalcium phosphate	1.15
Trace mineral premix[a]	.05
Salt	1.00
Vitamin A (1,000 IU/head/day)	.02
Chorotetracycline (80 mg/head/day)	.04

[a]Premix contained 10% iron, 1% copper, 0.1% cobalt, 0.3% iodine, 5% zinc, 10% magnesium, 14% calcium.

Table 12. Proximate analyses of sorghum hybrids and corn hybrids, summer, 1970. Dry matter basis.

Hybrid	Endosperm	Crude protein (%)	Ether extract (%)	Crude fiber (%)	Ash (%)	Nitrogen-free extract (%)	Gross energy Kcal/gm
G-766W	Y[a]	10.75	3.15	1.76	1.94	82.40	4.635
R-109	Y	11.05	2.85	1.64	1.75	82.70	4.635
E-57	Y	10.71	2.32	1.70	1.80	83.47	4.668
NK-222	Y	12.40	2.34	1.51	1.70	82.05	4.608
RS-671	W[b]	11.80	2.45	1.96	1.97	81.82	4.517
BR-1023	WBR[c]	14.08	3.09	2.40	2.16	78.27	4.734
Jumbo-C	W	11.82	2.84	1.49	1.56	82.29	4.516
High oil corn		12.22	5.65	2.20	1.80	78.13	4.742
Regular corn		10.70	3.66	2.21	1.79	81.64	4.439
2/3 waxy	W 2/3[d]	11.96	2.85	2.91	2.12	80.16	4.406
High lysine corn		10.91	5.22	2.41	1.96	79.49	4.484

[a]Yellow endosperm, [b]White endosperm, [c]Bird resistant, [d] 2/3 waxy genotype for parents.

Table 13. Proximate Analyses of Sorghum Grain and Corn, Complete Ration, Winter 1970-1971. Dry Matter Basis - with 1 pound 44% SBM, per Head per Day.

		%					
Hybrid	Endosperm	Crude protein	Ether extract	Crude Fiber	Ash	Nitrogen-free extract	Gross energy Kcal/gm
G-766W	Y[a]	12.45	2.60	2.42	4.04	77.96	4.436
R-109	Y	12.61	2.51	2.13	3.80	79.06	4.429
E-57	Y	11.68	2.36	2.25	3.80	79.90	4.406
NK-222	Y	13.53	2.14	2.03	4.27	78.02	4.365
RS-671	W[b]	13.50	2.96	2.14	3.99	76.99	4.577
BR-1023	WBR[c]	15.02	2.37	2.81	4.16	75.66	4.525
Jumbo-C	W	12.52	2.39	1.92	3.42	79.87	4.580
High oil corn		13.51	5.78	2.51	2.45	74.81	4.580
Regular corn		12.62	3.58	2.64	3.65	77.51	4.486
2/3 waxy	w 2/3[d]	12.89	2.49	3.33	3.89	77.38	4.512
High lysine corn		12.45	4.61	2.59	4.21	76.14	4.545

[a]Yellow endosperm
[b]White endosperm
[c]Bird resistance
[d]2/3 waxy genotype from parents.

Table 14. Mineral Content of Hybrid Sorghums, Summer, 1970. Dry Matter Basis.

Hybrid	Endosperm	%P	%Ca	PPM Fe	PPM Mg	PPM Mn	PPM Zn
G-776W	Y[a]	.383	.029	55.91	1366	8.15	26.85
R-109	Y	.345	.036	70.31	1442	7.62	22.04
E-57	Y	.380	.043	60.72	1723	8.67	22.34
NK-222	Y	.327	.029	58.60	1441	11.66	20.09
RS-671	W[b]	.301	.035	66.23	1382	11.23	70.34
BR-1023	WBR[c]	.376	.037	66.21	1413	11.14	76.67
Jumbo-C	W	.308	.044	74.04	1539	11.08	70.43
High oil corn		.382	.026	64.39	1456	10.50	77.32
Regular corn		.367	.031	68.67	1388	10.20	34.16
2/3 waxy	W 2/3[d]	.373	.077	79.79	1898	12.05	67.85
High lysine corn		.358	.026	58.38	1335	8.62	74.49

[a]Yellow endosperm
[b]White endosperm
[c]Bird resistant
[d]2/3 waxy genotype from parents

Part II

Feedlot Performance of Eight Hybrid Sorghum Grains and Three Hybrid Corns

R.L. McCollough, C.L. Drake, and G.M. Roth

Introduction

A 126-day feedlot trial was used to determine feedlot performances and nutritional values of eight hybrid sorghum grains and three hybrid corns (table 10, part I).

Materials and Methods

Each steer was implanted with 24 mg of diethylstilbestrol (DES) at the start of trial, and was weighed at noon on two consecutive days at the start and end of the trial. Respective means were used for starting and ending weights. The cattle were hand-fed twice daily. Carcass data were collected at slaughter.

The steers were started on a 50-50 ration of dehydrated alfalfa pellets and one of the hybrid grains, and brought to an all-concentrate ration in three weeks.

Results and Discussion

Table 15 shows that the steers on high oil corn ate less ($P<.05$) than those on Acco BR-1023. There was no significant difference in average daily gain. Differences among feed efficiencies of the nine hybrids (15 head per treatment) were highly significant ($P<.001$). Steers fed BR-1023 had the poorest feed efficiency (10.23); those fed E-57, the best (7.68). The hybrids are ranked by feed efficiency in table 16. Yellow endosperm hybrids and regular corn tended to have better feed efficiencies than white endosperm hybrids.

Table 16 compares feed efficiency of regular corn with those of bird resistant, yellow endosperm, and white endosperm hybrid sorghums. DeKalb E-57 was the only sorghum with better feed efficiency than regular corn. The four yellow endosperm sorghums had 95.1% the feed efficiency value of corn. The two white endosperms' feed efficiency was 85.82% that of regular corn, and 90.25% that of four yellow endosperm hybrid sorghums. Feed efficiency of yellow endosperm hybrids was 9.75% better than that of white endosperm hybrids.

Table 17 gives carcass data. Backfats were different ($P<.01$) among hybrids. Jumbo-C had the least (0.41 inch) backfat; G-766W, the most (0.64 inch). Differences in marbling or quality grade were not significant. BR-1023 gave a lower ($P<.05$) dressing percentage than did other hybrids.

Table 18 compares feedlot performance of nonsheltered and sheltered animals. Steers in sheltered lots gained faster ($P<.005$), ate less ($P<.001$), and had 24.77% better feed efficiency ($P<.001$) than those in nonsheltered lots.

Comparison among eleven hybrids fed in sheltered lots are shown in table 19. There were no significant differences in ADG or feed/day among hybrids. There was a significant ($P<.05$) difference for feed efficiency among hybrids.

Summary

Eight hybrid sorghum grains and three hybrid corns were fed in all-concentrate rations for 126 days to 139 Angus steers. There were 15 head per treatment (five individually fed in sheltered lots and 10 group fed in two lots of five each). The steers fed Acco-1023 (bird resistant) gained the least, had the lowest dressing percent, and poorest feed efficiency.

Feed efficiency data from this study indicates that a 105 pounds of yellow endosperm or 116.5 pounds of white endosperm sorghum grain would produce the same gain as 100 pounds of regular yellow dent corn. Feed efficiency of the 4 yellow endosperm hybrids was 9.75% better than that of the 2 white endosperm hybrids.

Table 15. Feedlot data: seven hybrid sorghums, three hybrid corns[a], 126 days, winter, 1970-1971, dry matter basis, all-concentrate rations, 15 head per hybrid (least square means).

Hybrid	Endosperm	Feed/day, lbs.	ADG, lbs.	Cost/cwt.[b] gain	Feed efficiency
E-57	Y[c]	15.78[fg]	2.06	15.99	7.68[f]
Regular corn	--	15.32[fg]	2.09	17.51	7.75[f]
G-766W	Y	16.28[fg]	2.05	16.78	8.07[f]
NK-222	Y	16.19[fg]	1.98	17.31	8.32[f]
R-109	Y	17.03[fg]	2.00	17.76	8.54[f]
RS-671	W[d]	16.46[fg]	1.91	17.34	8.84[fg]
High oil corn	--	15.00[g]	1.72	20.25	8.96[fg]
Jumbo-C	W	15.80[fg]	1.74	19.18	9.21[fg]
BR-1023	WBR[e]	17.64[f]	1.78	21.24	10.21[g]

[a] Rank according to feed efficiency

[b] Cost of sorghum ration $2.08/cwt. Cost of corn ration $2.26/cwt.

[c] Yellow endosperm.

[d] White endosperm.

[e] Bird resistant.

[fg] Means with different superscripts differ significantly (P<.05).

Table 16. Comparison of Feed Efficiencies of Nine Hybrids. Fed Winter 1970-1971. Fifteen Head/Hybrid.

			% value of[a]			
Hybrid	Endosperm	Feed efficiency	Regular corn	BR-1023	4 yellow endosperm	2 white endosperm
G-766W	Y[b]	8.07	104.13	79.04	99.02	89.36
R-109	Y	8.54	110.19	83.64	104.78	92.57
E-57	Y	7.68	99.23	75.32	94.36	85.16
NK-222	Y	8.32	107.35	81.49	102.08	92.14
RS-671	W[c]	8.84	114.06	86.58	107.47	97.70
BR-1023	WBR[d]	10.21	131.74	--	125.27	113.07
Jumbo-C	W	9.21	118.84	90.21	113.01	101.99
High oil corn	--	8.96	115.61	87.76	109.93	99.22
Regular corn	--	7.75	--	75.91	95.09	85.82
4 yellow endosperms avg.		8.15	105.16	79.82	--	90.25
2 white endosperms avg.		9.03	116.52	88.44	110.78	--

[a]Values above 100 indicate poorer feed efficiency, those below 100, superior feed efficiency. The amount above or below is the percentage increase or decrease in efficiency.

[b]Yellow endosperm

[c]White endosperm

[d]Bird Resistant

Table 17. Carcass data from steer fed one of nine hybrid grains, 15 head per treatment, winter, 1970-1971.

Hybrid	Fat thickness, in.	Yield Grade	Marbling[e]	Dressing %	Quality grade[f]
G-766W	0.64[a]	3.41	16.20	62.00[a]	10.50
R-109	0.55[abc]	3.06	15.25	61.52[a]	10.15
E-57	0.57[abc]	3.19	14.30	61.55[a]	9.65
NK-222	0.56[abc]	3.23	15.40	61.67[a]	10.20
RS-671	0.60[ab]	3.29	14.50	61.74[a]	9.80
BR-1023	0.44[cd]	2.93	13.90	59.28	9.35
Jumbo-C	0.41[d]	2.73	15.60	61.33[a]	10.30
High oil corn	0.48[bcd]	2.85	15.50	61.52[a]	10.15
Regular corn	0.53[abcd]	3.00	16.95	61.86[a]	10.90

Least Square Means

[a,b,c,d]Means with different superscripts differ significantly ($P<.05$).

[e]Average small-14, average modest-17

[f]Average good-8, average choice-11

Table 18. Sheltered compared with nonsheltered animals. All concentrate rations, winter 1970-1971.

Item	Sheltered (5 head/treatment)	nonsheltered (10 head/treatment)	P
Gain, lbs./day	2.05	1.80	<.005
Feed/day, lbs.	15.15	17.19	<.001
Efficiency	7.69[a]	9.57	<.001

[a]Least square means and efficiency cannot be reconstructed from mean gain and mean intake.

Table 19. Feedlot performance of 11 hybrids fed individually in sheltered lots.

Hybrid	No. head	ADG	Feed/day	Efficiency
G-766W	5	2.21	15.04	6.89^{bc}
R-109	5	1.95	15.88	8.39^{ab}
E-57	5	2.14	14.66	6.89^{bc}
NK-222	5	2.13	15.94	7.66^{abc}
RS-671	5	1.98	16.32	8.35^{ab}
BR-1023	5	1.76	15.20	9.16^{a}
Jumbo-C	5	1.89	14.75	7.82^{abc}
High oil corn	5	1.81	13.39	7.62^{abc}
Regular corn	5	2.51	15.09	6.26^{b}
2/3 waxy	2	2.23	15.58	6.95^{bc}
High lysine corn	2	2.03	13.73	6.75^{bc}

Least square means

[abc] Means with different superscripts differ significantly ($P<.05$).

Part III
Digestibility of Eight Hybrid Sorghum Grains And Three Hybrid Corns

R.L. McCollough and B.E. Brent

Introduction

Apparent coefficient of digestion (COD) was determined for eight hybrid sorghum grains and three hybrid corns named in Part I.

Material and Methods

The apparent COD was determined for the 11 hybrid grains described in Part I, using the 49 individually fed Angus steers previously described. Chromic oxide was used as a digestion indicator.

After a 63-day preliminary period and seven days before collections were started, each individual steer was adjusted to a constant feed intake that approximated free choice consumption. That intake was maintained through the collection period. Starting one week before collection, 100 grams of a pelleted chromic oxide premix (88 gm ground sorghum, 7 gm of dried molasses, 5 gm chromium oxide) was fed each morning. From each steer, 12 fecal samples were collected in 6 days. Sampling times were arranged to remove diurnal variation.

All means reported were calculated by least squares method.

Results and Discussion

Table 20 shows apparent digestibilities for the eight hybrid sorghums and three hybrid corns. Differences among hybrids for feed intake or digestibilities of crude fiber were not significant. Differences in digestibilities for crude protein were highly significant ($P<.001$) with BR-1023 (21.46) significantly lower than other hybrids. Hybrids differences for digestibility of NFE, dry matter and gross energy were significant ($P<.05$).

Table 21 shows percentages of digestible nutrients of the sorghum grain hybrids and corns. BR-1023 had less ($P<.001$) digestible crude protein than other hybrids. The corn tended to have more digestible crude protein than the sorghum grain. Digestible ether extract was higher for the corns than for sorghum because corns had higher ether extract contents. Corns tended to have more digestible NFE and TDN than sorghum grains, with BR-1023 ranking lowest.

Digestible energy (Kcal per gram) was less ($P<.01$) for R-109 (2.803) and BR-1023 (2.824) than for the other hybrids.

Summary

Chromic oxide was used to determine digestibilities of eight hybrid sorghum grains and three hybrid corns.

The digestibilities of crude protein were significantly lower ($P<.001$) for ACCO 1023 (bird resistant, 21.46) than for the others. In general, digestibilities were higher for hybrid corns than for hybrid sorghum grain, and Nc^+ RS-671 (white endosperm) grains tended to be lower than yellow endosperm grains. BR-1023 tended to be the least digestible of the hybrid sorghum grains.

Table 20. Apparent digestibilities of eight hybrid sorghum grains and three hybrid corns (least square means).

Hybrid	No. head	Daily feed intake, lb.	Apparent digestibilities					
			Crude protein	Crude fiber	Ether extract	Nitrogen free extract	Dry matter	Gross energy
G-766W	5	15.79	51.02^{bcd}	17.98	28.63^{bcd}	80.00^{abc}	71.18^{abcd}	68.77^{abc}
R-109	5	15.85	51.39^{bcd}	32.14	45.08^{ab}	71.34^{bc}	66.38^{cd}	60.47^{c}
E-57	5	14.96	49.40^{cd}	28.18	37.84^{bc}	76.61^{abc}	70.13^{bcd}	68.51^{abc}
NK-222	5	15.61	55.30^{abcd}	33.86	19.01^{d}	79.59^{abc}	72.40^{abcd}	69.91^{abc}
RS-671	5	16.16	46.01^{d}	19.59	59.82^{a}	70.79^{c}	64.30^{d}	64.85^{bc}
BR-1023	5	13.96	21.46	15.89	22.50^{cd}	77.16^{abc}	63.36^{d}	59.66^{c}
Jumbo-C	5	15.53	46.62^{d}	26.38	16.19^{d}	81.16^{abc}	72.61^{abcd}	70.24^{abc}
H. oil corn	5	12.96	57.77^{abc}	33.68	58.72^{a}	81.50^{ab}	74.07^{abc}	71.09^{abc}
Reg. corn	5	14.42	61.56^{ab}	45.00	61.45^{a}	86.52^{a}	79.78^{a}	78.13^{a}
H 2/3 waxy	2	16.37	57.66^{abc}	27.92	46.05^{ab}	84.41^{a}	76.62^{ab}	73.85^{ab}
H lys. corn	2	14.41	62.35^{a}	41.38	57.44^{a}	84.33^{a}	78.00^{a}	75.84^{ab}

^{a,b,c,d} Means with different superscript differ significantly ($P<.05$).

Table 21. Percentages of digestible nutrients of eight hybrid sorghum grains and three hybrid corns (least square means).

	Dry matter basis					
Hybrid	Crude protein	ether extract	Crude fiber	Nitrogen free extract	TDN	Dig. energy Kcal/gm
G-766W	5.48^{ab}	$.90^{cde}$	$.32^{cd}$	65.92^{abcd}	73.74^{bc}	3.187^{d}
R-109	5.67^{ab}	1.28^{cd}	$.52^{bcd}$	59.00^{cd}	68.07^{c}	2.803
E-57	5.29^{b}	$.87^{cde}$	$.48^{bcd}$	63.94^{abcd}	71.67^{bc}	3.156^{d}
NK-222	6.85^{a}	$.44^{e}$	$.79^{bcd}$	65.30^{abcd}	73.93^{bc}	3.263^{d}
RS-671	5.43^{ab}	1.47^{b}	$.48^{d}$	57.92^{d}	67.14^{c}	2.929^{d}
BR-1023	3.02	$.70^{de}$	$.38^{cd}$	60.39^{bcd}	65.37^{c}	2.824
Jumbo-C	5.51^{b}	$.46^{e}$	$.39^{cd}$	66.79^{abc}	73.72^{abc}	3.172^{c}
H. oil corn	7.06^{a}	3.32	$.74^{abcd}$	63.67^{abcd}	78.94^{ab}	3.371^{c}
Reg. corn	6.58^{a}	2.25^{ab}	$.99^{a}$	70.63^{a}	83.26^{a}	3.468^{a}
2/3 waxy	6.90^{a}	1.31^{c}	$.81^{abc}$	67.66^{ab}	78.32^{ab}	3.253^{bc}
H. lys. corn	6.80^{a}	3.00^{a}	1.00^{ab}	67.03^{abc}	81.58^{ab}	3.401^{ab}

^{abcd} Means with different superscripts differ significantly ($P < .05$).

Summary of 1970-1971 Feedlot Performance and Digestibility of Eight Hybrid Grain Sorghums and Three Hybrid Corns

Acco 1023 (bird resistant) produced significantly poorer feed efficiency and lower dressing percentage than did other hybrids. Acco 1023 also had the lowest digestibilities for crude protein, nitrogen free extract, and gross energy. Regular yellow dent corn tended to have the best feed efficiency and highest digestibilities. Yellow endosperm hybrid grain sorghums tended to have better feed efficiencies than white endosperm hybrid sorghums. If different hybrid grains are compared using feed efficiency it would take 116.5 pounds of white endosperm and 105 pounds of yellow endosperm sorghum grain to produce the same grain as 100 pounds of regular yellow dent corn. Feed efficiency of the 4 yellow endosperm hybrid sorghums was 9.75% better than that of 2 white endosperm sorghums.

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Two-Year Summary
Four Hybrid Sorghum Grains Fed in All-Concentrate Rations to Steers

R.L. McCollough and R.R. Schalles

This station has grown and fed the same four (yellow endosperm) hybrid sorghum grains (Funk G-766W, Acco R-109, DeKalb E-57, and Northrup King 222) in an all-concentrate ration to steers two consecutive years. Results are summarized here.

Material and Methods

During the springs of 1969 and 1970, the hybrid indicated above were planted on the same irrigated bottom land near Manhattan, using similar production practices, fertilization, and harvesting.

Both years, the sorghum grain was dry rolled and incorporated into all-concentrate rations, formulated to meet minimum NRC requirements. The last 56 days of the 1970-1971 trial, 1 pound of 44% soybean meal was added per head per day. Both feeding trials lasted 126 days and used 15 steers per treatment. Ten were group fed in two pens of five in nonsheltered concrete lots, and five were individually fed in sheltered concrete lots open to the south.

Results and Discussion

Table 22 shows the proximate analyses of the same four (yellow endosperm) hybrid sorghum grains produced in different years. Differences by years were not significant.

Table 23 shows feedlot performance. Year had no significant effect on average daily gain or feed efficiency. Steers ate less ($P<.05$) in 1970-1971 (16.38 lbs./head/day) than in 1969-1970 (17.50 lbs./head/day), probably because of starting weights (728 vs. 761 lbs.). When data were pooled by year or hybrid, differences in gain, feed efficiency, or consumption between hybrids were not significant.

Table 24 shows the feedlot performance of the hybrids in sheltered (five head) and nonsheltered (10 head) concrete lots. Shelter did not significantly affect gain, but steers in sheltered lots ate less ($P<.001$) feed per day and had better ($P<.001$) feed efficiency (14.08%).

Table 25 compares two methods of determining digestibility. In 1969-1970, digestibility was determined by total collections in metabolism stalls (four steers, latin square design). In 1970-1971, five steers per treatment were fed chromic oxide indicator in individual concrete pens. Feed consumption was less ($P<.001$) (5.14 lbs. per day) for steers in metabolism crates than for steers fed in individual pens. Digestibility of crude protein, crude fiber, ether extract, dry matter, and gross energy were significantly higher for steers in metabolism stalls than for those in individual pens. Research at Kentucky has shown no significant difference between these methods except for dry matter digestion when consumption was equal. Digestibility of hybrids did not differ significantly among hybrids so differences in digestibility by steers likely represent intake differences.

Although digestibilities estimated by chromic oxide method were lower, they probably were closer to the feedlot digestibilities because confining animals to metabolism crates likely reduces their feed consumption. Many early digestion studies used total collection in crates or stalls.

Summary

Four hybrid (yellow endosperm) sorghum grains (Funk G-766W, Acco R-109, DeKalb E-57, and Northrup King 222) were used two consecutive years, 1969 and 1970. They were dry rolled and fed 126 days in all-concentrate rations to steers during the winters of 1969-1970 and 1970-1971. There were no significant differences, between years, or among hybrids for gain or feed efficiency. Feed intake was significantly greater in 1969-1970, probably because starting weight was heavier. Steers individually fed in sheltered lots had equal gain, but better ($P<.001$) feed efficiency and lower ($P<.001$) feed consumption than steers fed the same rations in nonsheltered lots.

Digestibilities of the hybrid sorghum grains were determined each year. Digestibilities of crude protein, crude fiber, ether extract, dry matter, and gross energy were significantly lower measured by the chromic oxide method. That method may estimate digestibilities for full feed conditions better than metabolism-stall method, which limits intake. Feed intake was higher ($P<.001$) for steers in individual pens than in metabolism stalls (15.56 vs. 10.42 lbs. per day).

Table 22. Proximate Analyses of 4 Hybrid Sorghum Grains, 2 Years[a], Dry Matter Basis

Hybrid	Year	Crude protein (%)	ASH (%)	Ether extract (%)	Crude fiber (%)	Nitrogen free extract (%)	Gross energy Kcal/gm.
Funk's G-766W	1969	10.65	1.54	3.20	2.03	82.77	4.572
	1970	10.75	1.94	3.15	1.76	82.4	4.635
Acco R-109	1969	10.49	1.69	3.18	2.12	82.52	4.520
	1970	11.05	1.75	2.85	1.64	82.70	4.635
DeKalb E-57	1969	10.17	1.58	2.92	1.87	83.43	4.552
	1970	10.71	1.80	2.32	1.70	83.47	4.608
Northrup King 222	1969	11.83	1.58	3.20	1.87	81.52	4.585
	1970	12.40	1.70	2.34	1.51	82.05	4.668

No significant differences due to hybrid or year.

[a] Produced under similar conditions on same irrigated bottom land both years.

Table 23. Feedlot performance of steers on the same 4 hybrid sorghum grains fed in all-concentrate rations, Winters 1969-70 and 1970-71, Dry matter basis.

Hybrid	year	no. head		ADG	feed/day	Feed efficiency
G-766W	69-70	15		2.17	18.07	8.49
	70-71	15		2.05	16.28	8.07
	Pooled means			2.11	17.17	8.28
R-109	69-70	14		2.33	17.02	7.37
	70-71	15		2.00	17.03	8.53
	Pooled means			2.17	17.05	7.97
E-57	69-70	15		2.30	18.04	8.10
	70-71	15		2.06	15.78	7.68
	Pooled means			2.19	16.93	7.87
NK-222	69-70	15		2.19	17.07	7.81
	70-71	15		1.97	16.19	8.32
	Pooled means			2.08	16.22	8.08
	Pooled means 4 hybrids		69-70	2.22	17.50[a]	7.95
			70-71	2.05	16.38[b]	8.15

[a,b]Means with different superscripts differ significantly P<.05.

Table 24. Feedlot performance of sheltered and nonsheltered steers fed one of four hybrids in all-concentrate rations, Dry matter basis, (Pooled for two years.)

Hybrid	ADG		Feed/day		Feed efficiency	
	S	N-S[a]	S	N-S	S	N-S
G-766W	2.11	2.11	15.29	19.04	7.45	9.13
R-109	2.19	2.15	16.21	17.88	7.67	8.28
E-57	2.30	2.08	16.31	17.55	7.32	8.42
NK-222	2.26	1.91	16.04	17.02	7.33	8.83
Pooled means 4 hybrids	2.21	2.06	15.96[b]	17.92[c]	7.44[b]	8.66[c]

[a]Sheltered lots, 5 head; N-S nonsheltered lots, 10 head.
[b,c]Means with different superscripts differ significantly (P<.001).

Table 25. Digestibilities of four hybrid sorghum grains.

	Year 1969-1970, total collection, metabolism stalls				Year 1970-1971, chromic oxide, sheltered pens			
	Hybrid				Hybrid			
	G-766W	R-109	E-57	NK-222	G-766W	R-109	E-57	NK-222
Feed/day, lbs.	10.28	10.22	10.49	10.70	15.79	15.85	14.96	15.62
Pooled		10.42^{a}				15.56^{b}		
Apparent COD								
Crude protein	67.76	66.07	65.45	64.36	51.02	51.39	49.40	55.30
Pooled		65.91^{a}				51.77^{b}		
Crude fiber	46.90	45.35	44.76	41.27	17.98	32.14	28.18	33.86
Pooled		44.57^{a}				28.04^{b}		
Ether extract	65.20	65.66	67.51	64.31	28.63	45.08	37.83	19.00
Pooled		65.67^{a}				32.64^{b}		
Nitrogen free extract	81.56	79.78	80.61	82.47	80.00	71.34	76.61	79.59
Pooled		81.11				76.88		
Dry matter	79.80	76.69	77.35	78.65	71.18	66.38	70.13	72.40
Pooled		78.12^{a}				70.02^{b}		
TDN	78.68	76.92	77.52	78.65	70.69	69.04	69.68	71.18
Pooled		77.94^{a}				69.40^{b}		
Gross energy	75.53	74.61	75.42	76.24	68.27	60.47	68.51	69.91
Pooled		75.45^{a}				66.91^{b}		

^{a,b}Means with different superscripts differ significantly ($P < .025$).

Feedlot Performance of Nine Hybrid Sorghum Grains Fed to Steers Winter, 1971-1972

R. L. McCollough, J. G. Riley, C. L. Drake, and G. M. Roth

Introduction

Previous trials here indicated a possible difference in nutritional values of different hybrid sorghum grains with yellow endosperm hybrids being superior to white endosperm. We compared feedlot performance of yellow endosperm, white endosperm, all waxy (amylopectin type starch), and part waxy hybrid sorghum grains.

Material and Methods

In the spring of 1971, nine hybrid sorghum grains were planted under similar conditions on the same irrigated bottom land used the past two years to produce grain for similar trials. Fertilization, planting, and harvesting were similar for each hybird. About 1000 bushels of each hybrid were harvested and stored separately until fed.

Table 26 describes the hybrids planted, NC+ RS-671 (RS-671) was used as the control.

Feedlot performance from the nine hybrid sorghum grains was tested with 135 head of Angus, Hereford, and Angus X Hereford steers averaging 666 pounds. Fifteen head were allotted randomly by weight to each treatment. Ten were group fed in two groups of five in nonsheltered, concrete lots, and five were individually fed in sheltered, concrete lots open to the south. Automatic waterers were available in each pen. Each steer was implanted with 24 mg of DES at the start of the trial and fed for 126 days.

The grain was dry rolled, and dehydrated alfalfa pellets were 10% of the ration. The ration in table 27 was formulated to meet minimum NRC requirements. Steers were started on a ration of 60% dehydrated alfalfa pellets and 40% grain and went to a 90% grain finishing ration in 3 weeks.

Means are reported as arithmetic means.

Results and Discussion

Hybrids with 2/3 or all waxy endosperm tended to yield less (table 28) than other hybrids, but 1/4 waxy hybrids compared well with others.

Proximate analyses and gross energy of the nine hybrids were essentially the same (table 29). Table 30 shows the proximate analyses of the complete rations.

Feedlot performance from the nine hybrids is shown in table 31 ranked according to feed efficiency. All waxy sorghum gave highest gains (2.52 pounds/day); NK-275 and RS-671, lowest gains (2.23 pounds/day and 2.25 pounds/day, respectively). Intake of 2/3 waxy (20.05 pounds/day) was greatest; and lowest for NK-275 (1/4 waxy) at 17.69 pounds/day.

Feed efficiency of yellow endosperm hybrids tended to exceed that of white endosperm hybrids. The average feed efficiency of the four yellow endosperms (G-766W, R-109, G-522 and NK-X4087) was 7.48 compared with 8.34 for RS-671, a white endosperm (table 32) a 10.31% advantage for yellow endosperms. NK-X4087 is an experimental hybrid, not commercially available. Average feed efficiency of the three commercial yellow endosperm hybrids was 7.29; 14% better than RS-671.

The all waxy, white endosperm feed efficiency was 7.27 compared with 7.24 for G-766W, 7.34 for R-109, and 7.29 for G-522 (all yellow endosperm hybrids), and 8.03 for the experimental yellow endosperm, NK-X4087. Average feed efficiency of the three white, part-waxy endosperm hybrids, NK-275 (1/4 waxy), NK-280 (1/4 waxy) and Funk's 3135 (2/3 waxy), was 7.98, 6.68% below the average of the four yellow endosperms but 4.32% better than the white endosperm RS-671. Our 1971-72 data agrees with 1970-71 data which showes the yellow endosperm hybrids had feed efficiencies of 10.39 and 9.75% better than the white endosperm.

Summary

The all waxy endosperm hybrid (Corpustar CP-622) and 2/3 waxy (Funk's 3135) yielded less than other hybrids. These and seven other hybrids were dry rolled and fed separately in 90% concentrate rations (10% dehydrated alfalfa pellets) to 15 steers (average weight, 666 pounds) for 126 days. Gain was highest (2.52 pounds/day for all waxy (Corpustar CP-622) and lowest for NC+ RS-671 and Northurp King 275, (1/4 waxy) both white endosperm hybrids. Feed efficiency of the four yellow endosperm hybrids (Fund G-766W, Acco R-109, Funk G-522, Northrup King X-4087) was 10.3% better than the white endosperm hybrid control (NC+ RS-671).

Table 26. Description of nine hybrid sorghum grains, fed winter, 1971-1972.

Hybrid	Abbrev. in text	Pericarp color	Endosperm description
Funk G-766W[a]	G-766W	White	Yellow
Acco R-109[a]	R-109	Red bronze	Yellow
Northrup King 275	NK-275	Red	White 1/4 waxy[b]
Northrup King 280	NK-280	Red	White 1/4 waxy[b]
Nc+ RS-671[a]	RS-671	Red	White
Corpustar CP-622	All waxy	White	White all waxy[b]
Funk G-522	G-522	Red bronze	Yellow
Northrup King X4087	NK-X4087	White	Yellow
Funk 3135[a]	2/3 waxy	Red	White 2/3 waxy[b]

[a]Used in previous trials.
[b]Waxy refers to amylopectic type of starch (α1-4, α1-6 linkage).

Table 27. Ration composition, 1971-1972 feeding trial.

Ingredients	% ration as fed
Sorghum grain	87.55
Dehydrated alfalfa pellets	10.00
Dicalcium phosphate	.33
Ground limestone	.18
Chlortetracycline (80 mg/head/day)	.04
Trace mineral premix[a]	.05
Salt	1.00
Urea	.85
Vitamin A premix (1000 IU/head/day)	.01

[a]10% iron, 1% copper, 0.1% cobalt, 0.3% iodine, 5% zinc, 10% magnesium, 14% calcium.

Table 28. Yield per acre of nine hybrids irrigated, summer, 1971.

Hybrid	Endosperm	Bushels/acre as harvested	% H_2O	Lbs. of dry matter/acre
G-766W	Y[a]	114.69	14.58	5486
R-109	Y	133.37	15.25	6330
NK-275	W[b] 1/4[c]	115.32	14.70	5509
NK-280	W 1/4	114.05	14.17	5482
RS-671	W	126.64	16.01	5056
All waxy	WA[d]	90.02	15.61	4254
G-522	Y	120.22	15.47	5691
NK-X4087	Y	117.98	15.31	5595
2/3 waxy	W 2/3	99.29	14.19	4771

[a]Yellow endosperm.
[b]White endosperm.
[c]1/4, 2/3 waxy genotype from parents.
[d]All waxy.

Table 29. Proximate analyses of nine hybrid sorghum grains, dry matter basis, summer, 1971.

		%					
Hybrid	Endosperm	Crude protein	Ether extract	Crude fiber	Nitrogen free extract	Ash	Gross energy Kcal/gm
G-766W	Y[a]	10.35	3.31	2.19	82.51	1.64	4.459
R-109	Y	10.30	3.04	2.10	82.00	1.56	4.513
NK-275	W[b] 1/4[c]	10.84	3.15	2.12	82.28	1.61	4.349
NK-280	W 1/4	9.91	3.11	1.99	83.36	1.63	4.484
RS-671	W	11.24	2.99	1.92	82.22	1.63	4.446
All waxy	WA[d]	11.19	2.97	1.91	82.31	1.62	4.425
G-522	Y	10.67	3.20	1.78	82.76	1.59	4.482
NK-X4087	Y	10.34	3.03	2.23	82.74	1.66	4.424
2/3 waxy	W 2/3	10.90	3.17	2.14	81.93	1.86	4.508

[a]Yellow endosperm.
[b]White endosperm.
[c]1/4, 2/3 waxy genotype from parents.
[d]All waxy.

Table 30. Proximate analyses of the complete rations, dry matter basis, winter, 1971-1972.

Hybrid	Endosperm	% Crude protein	% Ether extract	% Crude fiber	% Nitrogen free extract	% Ash	Gross energy Kcal/gm
G-766W	Y[a]	13.73	3.17	3.96	74.68	4.46	4.312
R-109	Y	13.78	2.82	3.71	74.52	5.17	4.284
NK-275	W[b] 1/4[c]	15.87	3.78	4.19	70.98	5.18	4.316
NK-280	W 1/4	14.24	3.29	3.69	74.58	4.20	4.376
RS-671	W	14.76	3.03	3.90	73.98	4.33	4.250
All waxy	WA[d]	15.57	3.42	3.80	72.83	4.38	4.368
G-522	Y	14.17	2.70	4.05	74.33	4.75	4.368
NK-X4087	Y	13.15	3.02	3.86	76.53	3.44	4.417
2/3 waxy	W 2/3	15.20	2.57	4.28	73.84	4.11	4.388

[a]Yellow endosperm.
[b]White endosperm.
[c]1/4,2/3 waxy genotype from parents.
[d]All waxy.

Table 31. Feedlot performance from nine hybrid sorghum grains.[a]

Hybrid	Endosperm	ADG, lbs.	Dry matter /day	Feed efficiency
G-766W	Y[b]	2.47	17.92	7.24
All waxy	W[c]A[d]	2.52	18.29	7.27
G-522	Y	2.46	17.90	7.29
R-109	Y	2.45	18.02	7.34
NK-280	W 1/4[e]	2.35	18.55	7.90
NK-275	W 1/4	2.23	17.69	7.95
NK-X4087	Y	2.36	18.92	8.03
2/3 waxy	W 2/3	2.48	20.05	8.08
RS-671	W	2.24	18.67	8.34

[a] Ranked according to feed efficiency.
[b] Yellow endosperm.
[c] White endosperm.
[d] All waxy endosperm.
[e] 1/4, 2/3 part waxy genotype from parents.

Table 32. Comparison of feed efficiencies of nine hybrid sorghum grains fed winter, 1971-1972. Fifteen head per hybrid.

Hybrid	Endo-sperm	Feed efficiency	% Value of[a]: 4 yellow endosperm	3 part waxy endosperm: White endosperm	3 part waxy endosperm	All waxy endosperm
G-766W	Y[b]	7.24	96.79	86.81	90.73	99.59
R-109	Y	7.34	98.13	88.00	91.98	100.96
NK-275	W[c]1/4[d]	7.95	106.28	95.32	99.62	109.35
NK-280	W 1/4	7.90	105.61	94.72	99.00	108.67
RS-671	W	8.34	111.50	--	104.51	114.72
All waxy	WA[e]	7.27	97.19	87.41	91.35	100.26
G-522	Y	7.29	97.45	87.41	91.35	100.26
NK-X4087	Y	8.03	107.35	96.28	100.63	110.45
2/3 waxy	W 2/3	8.08	108.02	96.88	101.25	111.14
4 yellow endosperm avg.		7.48	--	89.69	93.73	102.89
3 part waxy endosperm avg.		7.98	106.68	95.68	--	109.77

[a]Values above 100 indicate poorer feed efficiency; those values below 100 indicate superior feed efficiency. The amount above or below is the percentage increase or decrease.

[b]Yellow endosperm

[c]White endosperm

[d]1/4, 2/3 part waxy genotype from parents.

[e]all waxy endosperm

KSU

Starea(R), Urea, or Soybean Meal as a Protein Source in Growing and Finishing Cattle Rations

L. L. Tucker and L. H. Harbers

Introduction

Use of urea in beef cattle rations, particularly in rations containing high levels of roughage (growing-type rations), has been limited by urea's toxicity, segregation and mixing problems, palatability, and poor use by animals. We compared soybean meal, Starea (R)* (44% protein equivalent), Starea(R)* (60% protein equivalent), a milo-urea pellet, and a urea-infused milo berry material as protein (nitrogen) supplements in growing-type rations. Animals used in a nitrogen-balance study were then fed a 70% concentrate ration, receiving the same sources of protein.

Methods

Twenty-five steers of mixed breeding (10 Charolais-Brahman crosses, 10 Charolais-Hereford crosses, and 5 Angus-Hereford crosses) were allotted on a 2:2:1 ratio to five groups. Each group was randomly assigned one of the five rations (table 33). During a 56-day growth trial, the animals were individually penned in a slatted-floor barn, with access to block salt and water free choice. They were weighed at 28 and 56 days. After this 56-day trial, four animals from each group went on a nitrogen-balance study, and received the same rations. Following the nitrogen-balance study, they were grouped (five head per pen) and fed the same protein sources in a 70% concentrate ration (table 34) 72 days.

Results

Performance data for the growth and finishing trials are given in table 35. Results, because so few animals could be used, reflect only trends without statistically significant differences. Starea 44 appears to be as palatable as soybean meal (consumption data) and comparable as a protein supplement (gains and feed efficiency). The urea-infused milo berry material (B.M.) was less palatable and, hence, lowered consumption and gains. Milo-urea pelleted (M.U.P.) seems to be nearly equal to both soybean meal and Starea (R)44 in a growing ration, but apparently it was used less efficiently in finishing rations. Animals in the

*Starea(R)--an extruded milo-urea processed material

Starea(R) 60 group were the most efficient and made highest average gains during the growth trial, which may be explained by the greater amount of supplemental nitrogen that group received. With supplemental nitrogen equal in the finishing phase, the Starea(R) 60 group failed to perform so well as in the first trial.

Table 33. Growing rations in lbs./day/steer fed indicated protein sources.

Group	Corn silage *	Ground milo	SBM	St.44	MUP	B.M.	St. 60
1	24.57	3.00	1.50	--	--	--	--
2	24.20	3.00	--	1.50	--	--	--
3	24.13	3.00	--	--	1.50	--	--
4	22.01	3.00	--	--	--	1.50	--
5	25.15	3.00	--	--	--	--	1.50

* Corn silage fed ad. lib. These values are average daily consumption during the entire 56-day feeding period.

Table 34. Finishing rations in lbs./day/steer fed indicated protein sources.

Group	Corn silage*	Ground milo mix*[a]	SBM	St.44	MUP	B.M.	St. 60
1	8.47	21.39	1.15	--	--	--	--
2	8.13	20.50	--	1.15	--	--	--
3	8.04	20.29	--	--	1.15	--	--
4	7.47	19.26	--	--	--	1.15	--
5	8.44	21.55	--	--	--	--	.80

* Average daily consumption - 72 days

[a] Ground milo mix contained 98.73% ground milo, 0.5% salt, 0.75% ground limestone, 50 gm Vit. A (30,000 I.U./gm)/ton and 380 gm Aureomycin/ton.

Table 35. Growing and finishing data.

Indicated factor	1 SBM	2 Starea 44	3 MUP	4 B.M.	5 Starea 60
A.D.G. (56-day growing ration)	2.41	2.38	2.40	2.26	2.53
Feed efficiency (lbs. dry matter/ lb. gain)	6.53	6.56	6.43	6.29	6.19
A.D.G. (72-day finishing ration)	2.71	2.70	2.55	2.50	2.56
Feed efficiency (lbs. dry matter/ lb. gain)	8.76	8.70	8.83	8.56	9.18

Whole Corn Rations for Finishing Heifers: A Comparison of Self-fed and Mixed Supplement, with and without Salt.

L. H. Harbers, K. F. Harrison,
D. Richardson, and E. F. Smith

Twenty-four Hereford X Angus heifers averaging 714 lbs. were alloted by weight to four groups of six animals each to study effects on gain, feed intake, and feed efficiency of:

1. Free-choice whole corn without roughage.
2. Protein supplement either mixed with whole corn or supplied separately (free-choice).
3. Omitting salt.

Protein supplement (table 36) was pelleted for uniform consumption of nutrients, however, the pellets had to be ground when fed separately from whole corn to reduce consumption. Groups receiving the complete mixture received supplement in pelleted form (4% of ration) throughout the 85-day trial. Groups receiving salt had access to block salt. Animals were fattened 85 days. Carcass data are not yet available.

Results of the trial are summarized in table 37. Feeding supplement either separately or mixed with whole corn did not statistically affect average daily gain, however, gain tended to be higher in groups fed the mixed ration. Omitting salt from the ration for 85 days did not statistically affect gains. More free-choice supplement was consumed when salt was omitted, possibly to get the sodium content (.26% Na) of supplement compared with whole corn's .01% Na. When animals had access to salt, the highest consumption averaged only 12.24 gms/head/day, equivalent to 0.15% of the ration. The universally accepted dietary level of 0.5% salt was not necessary.

Heifers consumed two to three times more supplement when it was fed separately but tended to gain slightly less. The practice of mixing supplement with grain was confirmed.

Table 36. Composition of feedstuffs used in protein supplement.

Feedstuff	Amount / 100 lbs.
Soybean meal (49%)	77.90 lbs.
Ground milo	9.40 lbs.
Ground limestone	11.25 lbs.
Vitamin A (10,000 IU/gm)	77.20 gms.
MGA-100	127.10 gms.
Aurofac-10	204.30 gms.
Trace minerals (2-5)	254.20 gms.
Ground milo for premix	18.20 gms.

Table 37. Body weight, gain, feed intake, and efficiency data of heifers fed an all-concentrate ration 85 days.

Indicated Factor	Supplement fed separately		Supplement mixed with corn	
	no salt	salt	no salt	salt
No. of animals	6	6	6	6
Initial wt., lbs.	714	715	714	715
Final wt., lbs.	926	944	968	965
Gain, lbs./day	2.56	2.69	2.99	2.95
Daily feed intake, lbs.	17.28	19.38	17.98	17.59
Whole corn, lbs.	14.63	17.89	17.26	16.89
Supplement	2.65	1.49	.72	.70
% Protein of ingested feeds	13.51	11.20	10.20	10.20
Daily salt intake, gm.	---	6.90	---	12.24
Salt intake, % of ration	---	0.08	---	0.15
Feed/gain ratio (dry basis)	6.08	6.48	5.41	5.35

Starea, Urea, and Soybean Meal Compared in Wintering Rations for Cows on Bluestem Pasture

II. Effect on Birth and Weaning Weight of Progeny and Rebreeding Performance

L. L. Tucker, L. H. Harbers, and E. F. Smith

During the winter of 1970-71, 63 six-year-old, non-lactating, pregnant Hereford cows were divided into eight groups to compare a soybean meal-sorghum grain supplement with supplements containing either urea, Starea 44 (an expansion-processed mixture of sorghum grain and urea), or sorghum grain only (Bulletin 546, 1971, p. 28). Cows were fed each morning six days a week, 7 days' feed each six days. They had access to water, a salt-mineral-vitamin mix (55.1% salt; 36.7% dicalcium phosphate; 8.2% vitamin A premix) fed free-choice, and native winter pasture (table 38).

Soybean meal-supplemented cows lost 26 lbs. each from November to February (70 days), while Starea-fed animals lost 48 lbs. each. The most notable weight changes occurred in groups on the urea-sorghum grain (-75 lbs. each) or sorghum grain only (-79 lbs. each).

Birth weight, percentage of cows rebred, and 205-day adjusted weaning weights (steer equivalent) of calves born during and after the winter supplementation study are given in table 39. Results did not differ significantly, but cows fed no supplemental nitrogen tended to produce lighter calves at birth.

Average weaning weights were similar for calves whose mothers received either soybean meal or Starea 44. Calves from cows receiving either urea-sorghum grain or sorghum grain were lighter than calves from cows on other supplements.

Rebreeding percentages of all cows were lower than expected. Cows receiving the unprocessed urea-sorghum grain had more rebreeding problems than those receiving other experimental rations.

Table 38. Gestation and lactation rations fed daily to cows wintering on native bluestem pasture.

Protein supplement	Nitrogen source, lbs.	Sorghum grain, lbs.
	Gestation rations	
Soybean meal	1.00	2.00
Starea 44	1.00	2.00
Urea	0.13	2.87
None	--	3.00
	Lactation rations	
Soybean meal	1.00	5.00
Starea 44	1.00	5.00
Urea	0.13	5.87
None	--	6.00

Table 39. Production data of cows and their calves during and following winter supplementation.

	Cows			
Protein supplement	Weight loss (70 days)	% rebred	Birth wt. lb.	Adj. weaning wt. lb.
Soybean meal	26#	67 (10/15)	73 (62-83)*	400 (305-447)*
Starea 44	48#	60 (9/15)	70 (59-85)*	401 (336-521)*
Urea	75#	43 (7/16)	72 (59-95)*	386 (308-427)*
None	79#	62 (10/16)	68 (57-75)*	365 (249-439)*

*Range of weights in parenthesis.

Effect of Feeding Insecticide to Cattle on Growing and Finishing Rations

L. H. Harbers, C. W. Pitts, K. F. Harrison
L. L. Tucker, and E. F. Smith

A convenient method to control flies in cattle manure is adding an insecticide to the ration. The chemical passes through the digestive tract and effectively controls fly larvae in the manure. It may also influence animal performance. We added an insecticide at 50 p.p.m. to a high roughage growing ration and to an all-concentrate finishing ration and measured performance by growth, feed intake, and feed efficiency in steers and heifers.

For the high roughage ration 10 steers were divided into two equal weight groups and fed a basal ration of corn silage, rolled milo, and soybean meal (see table 33 for ration composition). The steers were individually fed twice daily with free access to block salt and water for 56 days. Five were controls; five received the insecticide* hand mixed at the bunk.

Twenty-four heifers were fed an all-concentrate finishing ration. They were divided into four groups by weight and fed a mixture of 96% whole corn and 4% protein supplement (see table 36 for ration composition). Two groups were controls; two groups received a supplement containing the same insecticide. Each ton of pelleted supplement contained 2270 gm of a 50% premix of the insecticide (50 p.p.m.). All animals had free access to water. One control and one treated group had access to block salt; the others got only sodium that occurs naturally in feedstuffs. Animal performance was determined by gain, feed intake, and feed efficiency.

High-roughage data are in table 40. Rabon(R) had no statistical influence on animal performance, but it tended to lower gains. The nonsignificant trend of greater feed efficiency for the control group may have resulted from differences in weight between the two groups because feed intake as a percentage of body weight was near the expected for individually penned animals (table 40).

The lower average daily gain of animals fed the insecticide in whole corn diets was not significant

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*Rabon(R) kindly supplied by Shell Chemical Co.., San Ramone, Calif.

statistically. No statistically significant differences (P<.05) were observed in feed intake or feed efficiency between insecticide-fed and control cattle. Salt blocks had no influence on gain, feed intake, or feed efficiency. Salt voluntarily consumed was less than is usually added to animal rations (table 41).

Adding 50 p.p.m. Rabon(R) to growing and finishing rations resulted in slightly lower average daily gains but had no influence on feed consumption. Our results indicate that adding such an insecticide to the ration is a possible method to control flies.

Table 40. Growth, feed intake, and feed efficiency of steers individually fed a high roughage ration with or without 50 p.p.m. insecticide.

Item	No insecticide	Insecticide
No. of animals	5	5
Days on feed	56	56
Initial wt., lbs.	561	688
Final wt., lbs	696	800
Observed gain, lbs./day	2.41	2.00
Expected gain, lbs./day	2.00	1.89
Observed/expected gain ratio	1.20	1.06
Daily feed intake (as fed), lbs.	28.70	31.33
Daily feed intake (dry), % of body wt.	2.16	1.99
Silage (dry), lbs./day	9.77	10.80
Milo (dry), lbs./day	2.56	2.60
Protein supplement (dry), lbs./day	1.28	1.30
Feed/gain ration (dry matter basis)	5.64	7.35

Table 41. Growth, feed intake, and feed efficiency of heifers fed a concentrate ration with or without 50 p.p.m. insecticide.

	No insecticide		Insecticide	
Item	No salt	Salt	No salt	Salt
No. of animals	6	6	6	6
Initial wt., lbs.	714	715	714	715
Final wt., lbs.	968	965	955	950
Gain, lbs./day	2.99	2.95	2.86	2.76
Daily feed intake, lbs.	17.98	17.59	17.50	17.73
Feed/gain ration	5.41	5.35	6.12	6.42
Daily salt intake, gm	--	12.24	--	8.46
Salt intake, % of ration	--	0.15	--	.10

A New Approach to Polioencephalomalacia (PEM)

B. E. Brent, K. S. Lusby,
J. A. Kobuszewski and J. C. Parks

Description of the Problem

Polioencephalomalacia (PEM) is a disorder of the ruminant central nervous system characterized by sudden onset and rapid death. At autopsy, the brain may be swollen and cerebral cortex degenerated. Early symptoms may include disorientation and muscular incoordination. Affected animals may push against fences or other objects with their heads. More commonly, they are found dead or in a coma. If central nervous system damage is not excessive, animals with early symptoms respond to massive injections of thiamine, but may not recover coordination.

Its rapid and generally fatal course likely explains why little research has been done on the disease. The response to thiamine has raised many questions. Rumen nutritionists have long assumed that rumen microorganisms synthesized enough thiamine to meet an animal's needs. Even if none were produced in the rumen, normal diets should furnish enough thiamine.

Discovery of an Experimental Model

The Department of Animal Science and Industry established a project in 1969 to study control feed intake of ruminants--to find out how much feed an animal can metabolize, and the metabolic and biochemical limits on feed consumption. Sheep were fitted with rumen fistulas, and liquid diets were continuously pumped into their rumens. The diets were a suspension of starch, sugar, casein, vitamins A, D, E, and K, and all minerals known to be essential. Animals were on the diets for up to 21 days, and then died suddenly after body temperature and heart rate increased.

Autopsy showed no cause of death. However, young animals and those on high energy intakes died sooner than their counterparts. Serum minerals (sodium, potassium, calcium, phosphorus, magnesium, zinc, and copper), hemoglobin, hematocrit, blood carbon dioxide, oxygen, and pH, and serum protein and urea all were normal.

Two 79-pound lambs were started on infusion at a level designed to supply 100% of the maintenance requirement. To attempt to re-create the symptoms of previous animals, energy intake was increased to 125% of maintenance the second day. On day four, one was in a coma, with a rectal temperature of 106°F and a heart rate of 188. Thiamine (200 mg) was given in the jugular vein and 200 mg intramuscularly. In two hours, rectal temperature was 104°F and the heart rate, 165. In three hours, the animal could stand. However, it relapsed and died about 10 hours after thiamine injection. At autopsy, the brain was removed for detailed microscopic study. The cerebral cortex was degenerated. Apparently, brain degeneration had proceeded too far for recovery.

The second animal of the pair showed symptoms on day six of infusion, and was immediately treated with thiamine. Recovery was dramatic. Twenty-eight hours later, symptoms recurred, but again the animal responded to thiamine injection. It entered and recovered from thiamine deficiency a third time, and was removed from the experiment. Five months later, it developed urinary calculi and was autopsied. Classical brain changes of PEM were seen.

Another lamb was started on infusion, with 150 mg thiamine per day added to the liquid diet. After four weeks of infusion, thiamine was removed from the diet; 48 hours later, heart rate increased from 100 to 180 beats per minute, and three days later, to 220. The animal died in thiamine deficiency nine days after thiamine was removed.

To facilitate pumping, the liquid diet was modified using corn sugar instead of starch (table 42). It produced the same deficiency symptoms observed earlier.

Apparently, infusion of the semi-purified diet (table 42) into fistulated lambs serves as an animal model to study PEM. Since the syndrome can be re-created, research on it should continue.

Our results suggest that thiamine nutrition of ruminants should be reexamined. Nutritionists have long assumed that ruminants synthesize enough B vitamins to meet their needs.

Simple thiamine deficiency is unlikely for two reasons: 1. Most diets, particularly those high in concentrates, should contain enough thiamine; 2. the PEM syndrome develops much more rapidly than does thiamine deficiency in monogastric animals

The Thiaminase Hypothesis

We hypothesize that PEM is caused by the production of an enzyme, thiaminase, probably in the rumen. At least two types of thiaminase are known. One breaks the thiamine molecule to two parts. The other creates a molecule with a shape and formula similar (but not identical) to thiamine that acts as a thiamine antagonist. Amprolium, an effective coccidiostat, functions as a thiamine antagonist, and large doses have caused PEM in cattle.

The brain, in contrast to other body tissues, can obtain energy only from metabolized glucose. As glucose metabolism requires thiamine, production of thiaminase and a subsequent thiamine antagonist could explain the severe symptoms involving the central nervous system.

Summary

An experimental model for production of polioencephalomalacia (PEM) has been developed. We postulate that in PEM, the rumen microorganisms produce an enzyme, thiaminase, that either destroys thiamine or produces a thiamine antagonist. The antagonist could explain the lesions and symptoms involving the central nervous system. Further research is underway to examine: (1) the thiaminase and thiamine antagonist hypothesis, and (2) possible remedies.

Table 42. Liquid ration composition, maintenance, 100-lb. lamb.

Source	Amounts[1]	Source	Amounts[1]
Corn Sugar	735.8	NaCl	10.000
Casein	64.1	$CoCl_2 \cdot 6H_2O$	0.806[2]
$MnSO_4 \cdot H_2O$	137.070[2]	$CuCl_2$	33.884[2]
$K_2CO_3 \cdot 1\ 1/2\ H_2O$	37.396	KI	0.980[2]
$ZnSO_4 \cdot 7H_2O$	391.304[2]	$CrK(SO_4)_2 \cdot 12H_2O$	1.440[2]
$Na_2MoO_4 \cdot 2H_2O$	6.944[2]	$FeCl_2 \cdot 4H_2O$	1.100
$CaCl_2 \cdot 2H_2O$	11.715	Vitamin A	2200.000[3]
$NaH\ PO_4 \cdot H_2O$	11.586	Vitamin D	500.000[3]
$MgSO_4 \cdot 7H_2O$	10.761	Vitamin E	11.000[3]
$MgCl_2 \cdot 6H_2O$	4.068		

1 Expressed in grams per day unless indicated.
2 Milligrams per day.
3 Expressed as international units per day.

Prevention of Respiratory Disease In Weaning Calves[1]

R.R. Schalles[2], R.J. Milleret[3], Miles McKee[2], J.R. Olson[3], Jack Evans[2], and D.L. Carnahan[3]

Respiratory diseases of weanling calves are a continuous problem for ranchers. Each case is estimated to represent a $10 to $20 loss through veterinary costs, decreased gains, and death losses. There is also some question as to the effectiveness of certain preventative treatments. Few reliable experiments have compared medicative and management procedures of disease preventions. We evaluated preweaning vaccinations and weaning management practices.

Methods and Materials

Both four weeks and two weeks before being weaned, 52 calves were vaccinated with pasteurized bovine rhinotracheitis-parainfluenza-3. A modified live bovine rhinotracheitis-parainfluenza-3 vaccine was used on another group of 42 calves two weeks before weaning. Sixty-two calves received no vaccine. At weaning the 156 Polled Hereford calves were divided into three management groups. Thirty were weaned in a double fenced pen in the pasture where they were raised, to eliminate transportation stress. The remaining calves were trucked approximately six miles and divided into two lots with one lot receiving water and the other an electrolite mixture. The calves were fed to consumption twice each day prairie hay and a mixture of 60% dry rolled sorghum grain and 40% dehydrated alfalfa crumbles.

Weights were taken in the pastures at weaning and at weekly intervals for three weeks. Rectal temperatures were obtained every other day during the first week postweaning and at two weeks postweaning.

Calves with temperatures of 104°F. or over were treated, as were those determined by the herdsman to be clinically sick.

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[1] Thanks are extended to Elanco Products Company for all the vaccine and for performing serological work.

[2] Department of Animal Science and Industry.

[3] Department of Surgery and Medicine.

Sick animals were routinely treated with 10cc of Pen-Strep. Chronic cases were treated with Terramycin or Sulfa compounds.

Temperature and weight data were analyzed, using least squares analysis with weaning weight and weaning age as covariants to hold those two variables constant. Age of the dam and sex of the calf were included in the analysis. Chi-square analysis was used to analyze for differences in number of calves treated in the various groups.

Results

Table 43 gives performance results as interactions between weaning management and vaccination treatments were not significant ($P>.05$), only main factors are presented. Weaning stress did not increase temperature in general. Calves had either a normal temperature or a highly elevated temperature, above $104^{o}F$, so differences in average temperatures between weaning management or vaccination treatments were not significant. Significantly more ($P<.025$) calves that received the modified live vaccine were treated than those that received the pasteurized vaccine. Number of sick calves in the nonvaccinated group was intermediate. Weaning management accounted for no significant differences in number of sick calves, but the group with the largest percentage sick was the one weaned in the pasture. Calves weaned in the pasture required fewer treatments per sick calf than those in other management groups. Calves that received the pasteurized vaccine also required fewer treatments per sick calf than the nonvaccinated group or the group vaccinated with the modified live vaccine.

The average weaning weight was 395 ± 5.8 lbs. All groups lost weight during the first week with no significant differences. At the end of the second week, all groups except those weaned in the pasture had again reached their approximate weaning weights. The group weaned in the pasture lost weight throughout the three week trial. At the end of three weeks differences in weight among the groups vaccinated were not significant but both vaccinated groups weighed slightly more than the nonvaccinated group. Groups that received either electrolite or water continued to weigh significantly more than the group weaned in the pasture.

Discussion

Each of the past two years serious outbreaks of respiratory diseases have followed weaning in this herd. This year inclement weather persisted with precipitation 10 of the first 12 days. Maximum daily temperature ranged between 43^{o} and $80^{o}F$.; minimum, between 19^{o} to $61^{o}F$. No shelter was provided during the weaning period. Past history of the herd and severe weather should have stressed the calves enough to challenge their health. Under the conditions described the percentage of sick calves was lower for those vaccinated with pasteurized bovine rhinotracheites-parainfluenza^{-3} vaccine than for those not vaccinated or those vaccinated with a modified live vaccine.

Calves weaned in the pasture separated from their mothers by a double fence lost weight while those trucked 6 miles gained weight after the first week. Fewer calves that received electrolyte became sick and they required fewer treatments per sick calf than was true for calves that received water.

Table 43. Average calf performance (with standard errors) of calves receiving indicated weaning treatment.

	Vaccination treatment			Weaning management		
				Truck		
Variable	None	Killed	Live	Electrolite	Water	Pasture
No. calves	62	52	42	63	63	30
Temperature, F.						
2nd day	101.2±0.1	101.3±0.1	100.8±0.2	101.2±0.1	101.3±0.1	100.8±0.1
4th day	102.1±0.2	102.0±0.2	101.6±0.3	101.5±0.2	101.9±0.2	102.3±0.2
6th day	101.4±0.2	101.5±0.2	101.7±0.3	101.3±0.2	101.9±0.2	101.3±0.2
14th day	101.6±0.2	101.6±0.2	101.7±0.3	101.8±0.2	101.7±0.2	101.3±0.2
Weight, lbs.						
7th day	377.8±4.7	385.9±4.1	386.5±7.3	379.7±5.0	388.3±5.1	382.1±4.9
14th day	383.0±4.1	394.2±3.5	390.1±6.3	394.8±4.3	396.7±4.4	375.9±4.2
21th day	386.7±4.5	396.1±3.8	397.7±6.9	407.0±4.7	404.3±4.8	369.3±4.6
Treatments						
Calves treated	32%	12%	45%	25%	29%	37%
Treatment/calf treated	2.50	1.67	2.32	2.06	2.90	1.64

Dust Bags for Fly Control under Range Conditions

R.R. Schalles, C.W. Pitts, Jr.[1], Miles McKee,
and Jack Evans

Cattlemen have traditionally used various methods to control horn flies and, more recently, face flies. Many methods used require various amounts of labor and handling of cattle. Most recent efforts have stressed minimum labor. Dust bags that cattle rub to disperse insecticide is such a method. A study of the dust bag method of fly control is reported here.

Method and Procedure

Four approximately 300-acre adjacent pastures with about 30 Polled Hereford cows and calves, and yearling heifers each were used. Calves were born in March and April and weaned in late October. Half the pastures had dust bags near the water area under shade where cattle had loafed in previous years. No fly control was used in the other pastures. The cattle were weighed each month.

Results and Discussion

Weight gains did not differ significantly. Average gain by cows in pastures with dust bags was a nonsignificant 6 lbs. more, but their calves were one pound lighter than those in pastures with no fly control. Differences in percentages of animals treated for pinkeye were not significant.

Flies were not adequately controlled by dust bags in these pastures. Cows did not use them often enought to control flies.

Other fly control trials will be studied and reported.

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[1] Department of Entomology.

Evaluation of Crossbred Cows and Crossbred Bulls

R.R. Schalles, K.O. Zoellner, and R.J. Meier

Crossbred cows are common but interest in using crossbred bulls is recent. Little information is available on use of crossbred bulls, so advice and recommendations have been based on genetic principles rather than research. Nine mating combinations are reported here from using purebred and high grade Hereford, Santa Gertrudis, and crosses of Hereford and Santa Gertrudis cows and bulls.

Methods and Materials

Weaning weights of 613 calves born the fall of 1970 and the spring of 1971 were used. Adjusted 205-day weights were calculated by the procedure recommended by the Beef Improvement Federation (1970) and adjusted to steer bases. Preliminary analysis showed spring born calves 12 percent heavier than fall-born calves, so all fall calf weights were multiplied by 1.12. Means, standard deviations, and standard errors were calculated within mating groups.

Results and Discussion

Contrary to many reports, heterosis for growth to weaning was negative for all crosses, with F_1 calves (from Hereford mated with Santa Gertrudis) the extreme, followed by backcrosses, with F_2 progeny (calves from crossbred cows bred to crossbred bulls) the least negative. Positive heterosis was shown for maternal influence (probably milking ability) in crossbred cows. The crossbred bull gave a large negative heterosis (-27.8 lbs.).

The greatest variation is expected from crossbred cows mated to crossbred bulls; least variation, from purebred matings, producing either straight bred or first cross calves. Greatest variation in our data was in three of the four matings of purebred cows and purebred bulls. Variations in 205-day weight of calves from all other matings were somewhat grouped. More study is needed before explanations are attempted.

Our crossbred cows expressed heterosis for early breeding, with an average calving date one month earlier than the average for the two purebreds. Calves by crossbred bulls were born only slightly earlier than the average by purebred bulls.

Calves by purebred and crossbred bulls from purebred and crossbred cows were compared. Heterosis was positive for maternal contributions to weaning weight and early breeding. Calves by crossbred bulls were 27.8 lbs. lighter than the average of parent breeds, giving the crossbred bulls considerable disadvantage as compared to the average of the purebred bulls.

Table 44. Heterosis for indicated traits.

Trait	Heterosis	
	lbs.	%
Growth heterosis of F_1	-20.90	-4.1
Growth heterosis of F_2	- 2.25	-0.4
Growth heterosis of backcross	-18.85	-3.7
Maternal heterosis of crossbred cow	8.95	1.7
Paternal heterosis of crossbred bull	-27.80	-5.4
	Days	
Date-of-breeding heterosis of crossbred cow	-31.3	14.4
Date-of-breeding heterosis of crossbred bull	- 7.2	3.1

Rations for Performance Testing Bulls on a 140-day Gain Trial

Miles McKee, J. D. Evans and R. R. Schalles

Twenty-six Angus, Hereford, and Shorthorn bull calves were started on feed November 16, 1970, to study differences in protein content of rations. The bulls were from 184 to 302 days old. They were randomly assigned within breeds to one of three grain rations (see table 45) and individually fed free choice. The prairie hay they would clean up in 30 minutes was fed twice a day. They went from their pens into a large lot to exercise together approximately four hours a day.

Results of the gains are listed in table 46. Two were removed for health reasons midway through the test. The remaining bulls were halter broken, fitted, and shown in the Little American Royal for six weeks during the test by Kansas State University students. During this fitting period, ADG gains on bulls dropped below 1 pound a day. Gains on ration B or C did not differ significantly but both were significantly superior to ration A. Efficiencies of gain by the bulls from the three rations did not differ significantly.

Semen of the bulls was evaluated at the end of the test. Semen was collected by electro-ejaculation. Two bulls were aspermic; six produced semen questionable for range breeding, and 16 bulls produced semen satisfactory for range breeding. Semen production did not differ by ration.

Table 45. Grain ration for 140-day test of weight gained by bulls in test.

	Rations		
	A	B	C
Rolled oats, lbs.	1600.0	1455.0	1334.0
Steam flaked milo, lbs.	397.6	360.6	331.6
Soybean meal, lbs.	0	91.0	166.0
Dehydrated alfalfa, lbs.	0	91.0	166.0
Trace minerals, lbs.	1.0	1.0	1.0
Vitamin A, lbs.	0.8	0.8	0.8
Aurofac 10, lbs.	0.6	0.6	0.6
TDN content, %	76.8	76.3	75.9
Crude protein, %	11.35	13.41	14.76

Table 46. Response of bull calves to indicated ration, 140-day test.

	Rations		
	A	B	C
No. of bulls	7	8	9
Average age going on test, days	235	230	234
Average weight going on test, lbs.	519	467	497
Average weight off test, lbs.	810	863	872
ADG on test, lbs.	2.08	2.59	2.68
Lbs. grain/lbs. gain	6.41	5.58	5.91

Performance and Carcass Characteristics of Different Cattle Types--A Preliminary Report

M. E. Dikeman, H. J. Tuma, D. M. Allen,
M. L. May and M. D. Albrecht

This report contains results from the U. S. Meat Animal Research Center Cattle Germ Plasm Evaluation Program. Dr. Keith Gregory and Dr. Hudson Glimp, U. S. Meat Animal Research Center, Clay Center, Nebraska, initiated and designed the cattle germ plasm evaluation program. Kansas State University and the Livestock Division, C&MS, U.S.D.A. are cooperating on the project.

The project was designed to characterize breeds from different cattle types in the full spectrum of economic traits that relate to reproduction, maternal ability, growth, feed efficiency, and carcass and meat traits. Hereford, Angus, Jersey, South Devon, Limousin, Simmental, and Charolais breeds are represented as different biological types. Results of the first calf crop, including calving data, preweaning growth, postweaning feedlot growth and feed efficiency, and carcass and meat traits are presented here, along with postweaning growth and reproductive performance of the heifers in the first calf crop. This report is only preliminary; data from two additional calf crops will be combined with the data presented here.

Experimental Procedure

Commercial Hereford and Angus females were bred artificially to seven breeds of sires. The females were purchased as calves at weaning from commercial producers in Nebraska and were two, three, four and five years old at calving in 1970. The calves were born in late March, April and early May, and were creep fed a ration of whole oats beginning in mid-July.

Fourteen Hereford, 14 Angus, ten Charolais, eight Simmental, 14 South Devon, 12 Jersey and six Limousin sires were used in 1969. The Hereford and Angus bulls had been selected on individual performance information as a basis to be accepted for progeny testing by an artificial insemination organization.

[1]Appreciation is extended to Miss Jean Riggs and Mr. Coy Allen, Housing and Food Service, Kansas State University, for their excellent cooperation in this study.

The Charolais breed included three domestic and seven French bulls, The eight Simmental bulls included five available commercially in 1969, and three bulls that the Canada Department of Agriculture had imported for research. The Limousin bulls were the six available commercially after early July, 1969. The South Devon bulls were sampled from a commercial importation made early in 1969, and the Jersey bulls were selected at random from two artificial insemination organizations.

Because the number of progeny per sire is relatively low, general releases of information on individual sires is not released.

Calving difficulty scores presented in table 47 for two-year-old females and table 48 for three-, four-, and five-year-old females were assigned to each calf at birth using this scoring system:

Score		Description
1. No difficulty	-	Calves unassisted; however, sometimes necessary to straighten head and/or front legs.
2. Little difficulty	-	Assistance by hand, but no jack or puller used; assistance sometimes not required.
3. Moderate difficulty	-	Assistance with jack or calf puller; some difficulty encountered even then.
4. Major difficulty	-	Calf jack used and major difficulty encountered; usually 30 minutes or more required to deliver calf.
5. Caesarean birth	-	
6. Posterior presentation	-	

At weaning, steer calves with adjusted weaning weights three standard deviations below the mean (nine head) were removed from the study, The remaining steers were placed in the feedlot by breed of sire group (replicated with two lots per breed of sire) to obtain data on growth rate and feed efficiency. Weaning weights (table 49) were adjusted to a steer basis and to a four- or five-year-old cow basis. The adjustment factors were developed from these data and were as follows:

	Birth wt.	Preweaning A.D.G.	200-day wt.
Heifer calf adj.	+6	+.113	+29
Steer calf adj.	0	0	0
2-year-old dam	+8	+.265	+61
3-year-old dam	+3	+.033	+ 9
4- or 5-year-old dam	0	0	0

Feedlot rations are presented in table 50. Postweaning average daily gains (table 51) are based on actual weaning weights (no weaning shrink) and final weights at slaughter. Final weights at slaughter were the average of two weights (on feed and water) taken on different days to reduce errors from differences in fill. Adjusted final weight was obtained by adding postweaning average daily gain x days on feed to weaning weight adjusted to 200 days of age and to a four- or five-year-old dam basis. Average daily gains and adjusted final weights (415 days, 443 days, 471 days of age) (table 51) for each of the three slaughter groups are for steers slaughtered in that group only. Feed efficiency for each breeding group was obtained by dividing the cumulative average daily TDN consumption per steer by the average daily gain of the steers.

Approximately one-third of the steers in each breed of sire by breed of dam group was slaughtered at each of three slaughter dates (215, 243 and 271 days on feed after weaning). Steers to be slaughtered from each breeding group at each of the three times were identified at random across all birth dates. The steers averaged 28 days between slaughter groups 1 and 2 and between slaughter groups 2 and 3. However, birth dates did not average the same for all breeding groups because of differences in conception date and gestation length. Average birth dates are presented in table 49 by breeding group. The steers were transported to a commercial slaughter plant approximately 12 hours before slaughter, and were allowed to chill 24 hours after slaughter before carcass data were obtained. Carcasses were evaluated for conformation, maturity, marbling, color, texture, and firmness. U.S.D.A. Quality Grade was determined by representatives of the Livestock Division, C&MS, U.S.D.A., and Kansas State University. Loin eye area (tables 52 and 53). Additional selected linear carcass measurements and measures of other traits were obtained that are not included in this report.

The right side of each carcass was transported to Kansas State University approximately 56 hours after slaughter to obtain detailed cut-out and meat quality data. Each side was separated into wholesale cuts, and the wholesale cuts were processed into closely trimmed, boneless cuts with no more than 0.30 in. of fat on any surface. Amounts of retail product, fat trim, and bone were determined for each wholesale cut (table 54).

One steak was removed from each carcass at the 11th rib for Warner-Bratzler shear determination. The steaks were cooked at 350°F to an internal temperature of 150°F. After cooling for approximately 30 minutes at room temperature, one-half inch cores were removed for shear determination. Steaks were removed at the 10th rib from four representative carcasses per breed group per slaughter date (168 carcasses), cooked at 350°F to an internal temperature of 150°F, and subjected to taste panel evaluation for tenderness, flavor, juiciness and overall acceptability by trained taste panelists (table 55).

Data for carcass and meat traits were analyzed by least squares procedures for unequal subclass numbers using a model that included effects of age of dam (two-, three, four-, and five-year-olds); breed of sire (straightbred Hereford and Angus, Hereford-Angus reciprocal crosses, Jersey, South Devon, Limousin, Simmental and Charolais); breed of dam (Hereford, Angus); time of slaughter, and breed of sire-breed of dam-time of slaughter; and birth date was included as a covariate to adjust for differences in age of calf within slaughter groups. Thus, the least-squares means for the carcass and meat traits are adjusted for age of dam and to 415, 443 and 471 days of age for the three slaughter groups.

Postweaning average daily gain and adjusted final weight for both steers and heifers were analyzed by least squares procedures using the same model except that birth date was not included as a covariate.

Postweaning growth, puberty and pregnancy data on the heifers in the first calf crop are presented in table 56. The heifers were kept in drylot from weaning through the artificial insemination breeding period (November 17-July 7). Their postweaning ration was 50% corn silage and 50% grass silage fed ad libitum. The adjusted 400-day weight is based on a full weight; the adjusted 550-day weight is based on a shrunk weight.

Date of puberty, defined as date of first observed standing estrus, was determined by checking animals for estrus twice daily. Body weights were taken every 28 days from weaning to the breeding period and again when the breeding period terminated. Heifers were inseminated only after standing for vasectomized bulls or other heifers. Following the artificial insemination breeding season (May 24-July 7, 45 days), heifers were placed on pasture for a 26-day natural service breeding period. The percentage of heifers reaching puberty by 15 months and the average age of those that reached puberty are for heifers observed in estrus up to the end of the artificial insemination breeding season only; the percentage pregnant includes heifers that may have reached puberty and bred during the 26-day natural service breeding period.

Results and Discussion

Many differences reported here are large enough that additional data should add to their significance. However, many differences are too small to be interpreted as statistically valid or actual differences.

Calving difficulty scores on two-year-old females indicate calving difficulty in all crossbred combinations. However, more difficulty occurred with Limousin, Simmental, South Devon, and Charolais sired calves than with others. The Jersey sired calves caused the least difficulty in calving, as expected. Slightly more difficulty was encountered with Hereford than Angus dams.

Fewer calving problems occurred in the three-, four-, and five-year-old females than in two-year-old females with little difference between Hereford and Angus dams. However, Simmental and Charolais calves still caused some problems with Limousin and South Devon calves intermediate in calving difficulty.

Adjusted weaning weights for Simmental and Charolais calves were higher than weights of other calves. Limousin calves were slightly lighter than Simmental or Charolais calves. South Devon calves were intermediate in weight and simialr to the Angus-Hereford reciprocal cross calves. Purebred calves were lightest except for Jersey crosses. Calves from Angus cows tended to be slightly heavier than calves from Hereford cows at weaning.

All steers averaged a modest 2.45 pounds during the feedlot period, undoubtedly due to the high roughage ration. Simmental and Charolais calves appeared to have an edge over the other calves. Jersey calves were lowest in average daily gain while the purebred calves, Angus-Hereford reciprocal crosses, and Limousin calves were intermediate in gain. South Devon calves were slightly above average in postweaning growth. In general, TDN efficiency was related to postweaning growth rate, with the faster gaining calves having some advantage in feed efficiency. One exception to that generalization was Limousin's feed efficiency being nearly as good as any sire breed, but their daily gain was only about average. Calves from Hereford dams appeared to out-perform calves from Angus dams.

Differences in dressing percentages were not large, but Jerseys were the lowest of all breeds. Purebred and Simmental steers appeared to be intermediate in dressing percentage, while South Devons, Limousins, Charolais, and Angus-Hereford reciprocal crosses dressed slightly higher.

The 452 steers averaged low Choice on the rail. On a scoring system of 9 for high Good, 10 for low Choice, and 11 for average Choice, the calves out of Angus dams had a higher U.S.D.A. quality grade (10.6) than those out of Hereford dams (10.1). Only the Limousin steers failed to average low Choice (9.4). Jersey and Simmental steers averaged low Choice, slightly lower than the remaining breeds. There was essentially no increase in quality grade between cattle slaughtered at the three time periods. Variation in grade between breeds was less than expected.

Wider differences showed up in carcass cutability. Limousin, Simmental, and Charolais sired steers had larger rib eyes with better U.S.D.A. yield grades than other sire breeds did. Limousin, Simmental, Charolais and Jersey steers tended to have less fat at the 12th rib than the other sire breeds. Purebred Angus and Hereford and their reciprocal crosses had more fat cover than any of the other breeds.

The Limousins appeared to have a higher cutability percentage than other breeds (56.6%); Simmental and Charolais steers were considerably above average (53.8 and 54.6%, respectively). Differences were small among the remaining breeds. Limousins had the least fat trim, followed closely by Simmental and Charolais steers. The South Devons were intermediate in fat trim, while Angus-Hereford reciprocal crosses seemed to have the most fat trim. Percentage of carcass bone varied only about one percent among all breeds.

Warner-Bratzler shear data suggests little variation among breeds and that all breeds had steaks with desirable tenderness. Taste panel tenderness scores also showed steaks "moderately tender" with little variation among breeds. Scores for steak flavor, juiciness, and overall acceptability were "moderately desirable" with rather small differences among breeds.

Preliminary data for growth and reproductive performance of heifers indicate that heifers from Angus dams had higher 200-day postweaning gains and a higher percentage reaching puberty at 15 months. Also, a higher percentage of heifers from Angus dams were pregnant than heifers from Hereford dams after the breeding season.

Except for Jersey heifers, crossbreeding showed some advantage in postweaning growth over straightbreeding. Simmental and Charolais heifers appeared to have an edge in postweaning growth over all other breeds. Except for South Devon crosses, crossbreeding also showed some advantage in fertility. At 15 months of age, 87% of all crossbred heifers had showed signs of estrus versus 69% for the straightbred Angus and Herefords. After a ten-week breeding season, 92& of all crossbred heifers were pregnant versus 74% for straightbred cattle. A higher percentage of the Jersey and Angus-Hereford reciprocal crosses were pregnant than for other breeds.

Table 47. U.S. Meat Animal Research Center Germ Plasm Evaluation calving difficulty summary, 1970 calf crop, 2-year-old females.

Breed of sire	Breed of dam	No of calves	Calving difficulty score 1 No.	1 %	2 No.	2 %	3 No.	3 %	4 No.	4 %	5 No.	5 %	6 No.	6 %	Dead at or shortly after birth No.	Dead %
Hereford	Hereford	25	8	32.0	2	8.0	1	4.0	13	52.0	1	4.0	0		0	
Angus	Angus	44	29	65.9	1	2.3	0		14	31.8	0		0		4	9.1
	Average	69	37	53.6	3	4.3	1	1.4	27	39.3	1	1.4	0		4	5.8
Angus	Hereford	37	16	43.2	3	8.1	1	2.7	17	46.0	0		0		5	13.5
Hereford	Angus	50	34	68.0	1	2.0	1	2.0	14	28.0	0		0		3	6.0
	Average	87	50	57.5	4	4.6	2	2.3	31	35.6	0		0		8	9.2
Jersey	Hereford	27	19	70.4	3	11.1	1	3.7	4	14.8	0		0		0	
	Angus	44	41	93.1	2	4.6	0		1	2.3	0		0		1	2.3
	Average	71	60	81.8	5	7.9	1	1.8	5	8.6	0		0		1	1.2
South Devon	Hereford	15	5	33.3	2	13.3	2	13.3	5	33.3	1	6.7	0		1	6.7
	Angus	33	12	36.4	1	3.0	2	6.1	17	51.5	1	3.0	0		4	12.0
	Average	48	17	34.9	3	8.2	4	9.7	22	42.4	2	4.9	0		5	9.4
Limousin	Hereford	37	4	10.8	1	2.7	2	5.4	26	70.3	3	8.1	1	2.7	3	8.1
	Angus	27	8	29.6	2	7.4	2	7.4	15	55.6	0		0		1	3.7
	Average	64	12	20.2	3	5.1	4	6.4	41	63.0	3	4.1	1	1.4	4	5.9
Simnental	Hereford	16	2	12.5	0		^		8	50.0	6	37.5	0		1	6.3
	Angus	17	8	47.0	1	5.9	1	5.9	5	29.5	2	11.7	0		2	11.7
	Average	33	10	29.8	1	3.0	1	3.0	13	39.8	8	24.6	0		3	9.0
Charolals	Hereford	21	4	19.0	2	9.5	0		11	52.4	3	14.3	1	4.8	3	14.3
	Angus	22	6	27.3	0		1	4.6	15	68.1	0		0		3	13.6
	Average	43	10	23.2	2	4.8	1	2.3	26	60.3	3	7.2	1	2.4	6	14.0
Average	Hereford	178	58	32.6	13	7.3	7	3.9	84	47.2	14	7.9	2	1.1	13	7.3
All Sire	Angus	237	138	58.2	8	3.4	7	3.0	81	34.2	3	1.3	0		18	7.6
Breeds	Average	415	196	45.4	21	5.4	14	3.5	165	40.7	17	4.6	2	.6	31	7.5

Table 48. U.S. Meat Animal Research Center Germ Plasm Evaluation calving difficulty summary, 1970 calf crop, 3-, 4-, 5-year-old females.

Breed of sire	Breed of dam	No. of calves	Calving difficulty score 1 No.	1 %	2 No.	2 %	3 No.	3 %	4 No.	4 %	5 No.	5 %	6 No.	6 %	Dead at or shortly after birth No.	%
Hereford	Hereford	37	34	91.9	1	2.7	1	2.7	0		0		1	2.7	2	5.4
Angus	Angus	32	30	93.8	0		1	3.1	1	3.1	0		0		2	6.3
	Average	69	64	92.6	1	1.5	2	2.9	1	1.5	0		1	1.5	4	5.8
Angus	Hereford	29	29	100.0	0		0		0		0		0		0	
Hereford	Angus	47	44	93.6	2	4.3	0		1	2.1	0		0		0	
	Average	76	73	96.1	2	2.6	0		1	1.3	0		0		0	
Jersey	Hereford	29	28	97.0	0		1	3.0	0		0		0		1	3.0
	Angus	32	32	100.0	0		0		0		0		0		0	
	Average	61	60	98.5	0		1	1.5	0		0		0		1	1.5
South Devon	Hereford	17	12	70.0	1	6.0	2	12.0	2	12.0	0		0		1	6.0
	Angus	12	12	100.0	0		0		0		0		0		0	
	Average	29	24	85.0	1	3.0	2	6.0	2	6.0	0		0		1	3.0
Limousin	Hereford	44	38	87.0	1	2.0	1	2.0	3	7.0	0		1	2.0	2	5.0
	Angus	42	33	78.0	2	5.0	2	5.0	4	10.0	0		1	2.0	3	7.0
	Average	86	71	82.5	3	3.5	3	3.5	7	8.5	0		2	2.0	5	6.0
Simmental	Hereford	64	45	71.0	6	9.0	4	6.0	9	14.0	0		0		10	16.0
	Angus	72	59	82.0	2	3.0	3	4.0	7	10.0	0		1	1.0	4	6.0
	Average	136	104	76.5	8	6.0	7	5.0	16	12.0	0		1	0.5	14	11.0
Charolais	Hereford	64	46	72.0	3	5.0	6	9.0	7	11.0	0		2	3.0	8	13.0
	Angus	67	53	79.0	0		2	3.0	9	13.0	0		3	5.0	5	7.0
	Average	131	99	75.5	3	2.5	8	6.0	16	12.0	0		5	4.0	13	10.0
Average	Hereford	284	232	81.7	12	4.2	15	5.3	21	7.4	0		4	1.4	24	8.5
All Sire	Angus	304	263	86.5	6	2.0	8	2.6	22	7.2	0		5	1.7	14	4.6
Breeds	Average	588	495	84.1	18	3.1	23	4.0	43	7.3	0		9	1.5	38	6.6

Table 49. U.S. Meat Animal Research Center Germ Plasm Evaluation preweaning summary, 1970 calf crop.

Breed of sire	Breed of dam	No. of calves	Birth date	Birth wt.	Preweaning A.D.G.	Adjusted 200-day wt.	200-day wt. ratio
Hereford	Hereford	55	April 17	80	1.82	445	94.7[b]
Angus	Angus	66	April 6	72	1.95	463	96.0[c]
	Average	121	April 12	76	1.89	454	95.4[d]
Angus	Hereford	59	April 13	81	1.90	460	97.9
Hereford	Angus	87	April 8	78	2.01	479	99.4
	Average	146	April 11	80	1.96	470	98.7
Jersey	Hereford	53	April 13	73	1.90	452	96.4
	Angus	71	April 2	66	1.90	444	92.2
	Average	124	April 7	69	1.90	448	94.3
South Devon	Hereford	28	April 13	85	1.90	466	99.1
	Angus	39	April 9	81	2.00	482	100.0
	Average	67	April 11	83	1.95	474	99.5
Limousin	Hereford	70	May 2	87	1.94	476	101.5
	Angus	63	April 26	84	2.06	496	102.9
	Average	133	April 29	86	2.00	486	102.2
Simmental	Hereford	65	April 21	93	1.99	491	104.5
	Angus	78	April 11	85	2.09	503	104.4
	Average	143	April 16	89	2.04	497	104.4
Charolais	Hereford	68	April 18	92	2.03	498	106.1
	Angus	76	April 11	85	2.11	507	105.2
	Average	144	April 14	88	2.07	502	105.6
Average All Sire Breeds	Hereford	398	April 18	84	1.93	470	100.0
	Angus	480	April 10	78	2.02	482	100.0
	Average	878	April 14	81	1.97	476	100.0

[a] Includes all steer and heifer calves weaned.
[b] Ratio computed relative to average for Hereford cows, adjusted to a steer calf and to a 4- and 5-year-old cow basis.
[c] Ratio computed relative to average for Angus cows, adjusted to a steer calf and a 4-and 5-year-old cow basis.
[d] Ratio computed relative to overall average adjusted to a steer calf and a 4 and 5-year-old cow basis.

Table 50. U.S. Meat Animal Research Center Germ Plasm Evaluation postweaning steer, feedlot rations.

Ingredient	Nov. 17-Nov. 24	Nov. 25-Jan. 10	Jan. 11-Apr. 28
	%	%	%
Corn silage	89.0	77.5	60.0
Concentrate[1]	7.5	17.5	35.0
Supplement, 38% crude protein[2]	3.5	5.0	5.0
Ration analyses, 90% dry matter basis			
Crude protein, %	10.6	11.6	10.8
Digestible protein, %	8.1	8.9	8.6
Total digestible nutrients, %	64.8	68.0	71.6

[1]The concentrate portion included varying amounts of ground shelled corn, ground sorghum grain, and ground wheat.

[2]Composition of a ton of supplement: 1492 lb. soybean meal; 200 lb. salt; 100 lb. dicalcium phosphate; 130 lb. ground limestone; 7.0 lb. vitamin ADE premix (4,000,000 IU Vitamin A/lb.); 1.4 lb. Aureomycin (50 grams/lb.); 10 lb. trace mineral premix; 60 lb. ammonium chloride.

Table 51. U.S. Meat Animal Research Center Germ Plasm Evaluation least squares means for postweaning average daily gains, adjusted final weights, and TDN efficiencies

Breed of sire	Breed of dam	No. of steers[a]				Postweaning average daily gain[b], lb.				Adjusted final weight[c], lb.				TDN efficiency[d]			
		215	243	271	Total	215	243	271	Avg.	215	243	271	Avg.	215	243	271	Avg.
Hereford	Hereford	8	8	7	23	2.43	2.38	2.38	2.40	969	1017	1098	1028				
Angus	Angus	13	12	13	38	2.48	2.26	2.26	2.34	1006	1016	1072	1032				
	Average	21	20	20	61	2.45	2.32	2.32	2.37	988	1017	1085	1030	5.97	6.45	6.58	6.33
Angus	Hereford	10	11	10	31	2.45	2.52	2.40	2.45	980	1077	1108	1055				
Hereford	Angus	18	17	16	51	2.38	2.37	2.36	2.37	986	1066	1116	1056				
	Average	28	28	26	82	2.42	2.44	2.38	2.41	983	1071	1112	1055	6.11	6.47	6.76	6.45
Jersey	Hereford	7	8	8	23	2.36	2.15	2.24	2.25	953	965	1072	997				
	Angus	15	14	14	43	2.22	2.18	2.08	2.16	931	973	1024	976				
	Average	22	22	22	66	2.29	2.16	2.16	2.20	942	969	1048	986	6.58	6.88	7.11	6.86
South Devon	Hereford	3	4	3	10	2.37	2.58	2.73	2.56	970	1069	1217	1085				
	Angus	6	8	7	21	2.62	2.56	2.31	2.50	1053	1096	1104	1084				
	Average	9	12	10	31	2.50	2.57	2.52	2.53	1012	1082	1161	1085	5.88	6.38	6.66	6.31
Limousin	Hereford	12	12	11	35	2.61	2.54	2.22	2.45	1069	1100	1076	1082				
	Angus	11	12	13	36	2.39	2.43	2.26	2.36	1014	1107	1115	1079				
	Average	23	24	24	71	2.50	2.48	2.24	2.41	1042	1103	1096	1080	5.86	6.20	6.57	6.21
Simmental	Hereford	10	10	10	30	2.78	2.64	2.68	2.70	1069	1125	1216	1137	5.54	6.04	6.19	5.92
	Angus	12	13	14	39	2.58	2.49	2.59	2.55	1064	1105	1222	1130	5.96	6.47	6.60	6.34
	Average	22	23	24	69	2.68	2.57	2.63	2.63	1067	1115	1219	1133	5.75	6.26	6.40	6.13
Charolais	Hereford	10	10	10	30	2.82	2.67	2.66	2.71	1106	1148	1223	1159	5.55	5.89	6.23	5.89
	Angus	14	14	14	42	2.52	2.47	2.44	2.48	1036	1105	1185	1108	6.06	6.56	6.72	6.45
	Average	24	24	24	72	2.67	2.57	2.55	2.60	1071	1126	1204	1134	5.80	6.22	6.48	6.17
Average	Hereford	60	62	59	181	2.54	2.50	2.47	2.50	1017	1071	1144	1077				
All Sire	Angus	89	91	91	270	2.46	2.40	2.33	2.39	1013	1067	1120	1066				
Breeds	Average	149	153	150	452	2.50	2.45	2.40	2.45	1015	1069	1132	1072	5.99	6.41	6.65	6.35

[a] Number of steers slaughtered after 215, 243, and 271 days on feed.
[b] Average daily gain = (final weight - weaning weight) ÷ days on feed.
[c] Adjusted final weight = adjusted 200-day weight + (postweaning average daily gain x days on feed postweaning).
[d] TDN efficiency = lb. TDN consumer per lb. gain; 90% dry matter basis for feed consumed.

Table 52. U.S. Meat Animal Research Center Germ Plasm Evaluation least squares means for adjusted hot carcass weight, dressing percentage and U.S.D.A. Quality Grade[a].

Breed of sire	Breed of dam	Adjusted hot carcass weight, lb.				Dressing %				U.S.D.A. Quality Grade[b]			
		215	243	271	Avg.	215	243	271.	Avg.	215	243	271	Avg.
Hereford	Hereford	585	614	659	619	60.9	60.4	60.5	60.6	10.0	10.3	10.0	10.1
Angus	Angus	608	618	657	628	60.9	61.2	61.6	61.2	11.3	11.2	11.1	11.2
	Average	596	616	658	623	60.9	60.8	61.1	60.9	10.7	10.7	10.5	10.6
Angus	Hereford	587	653	685	642	60.6	61.0	62.1	61.2	10.7	11.2	10.8	10.9
Hereford	Angus	594	654	692	647	60.6	61.6	62.4	61.5	10.0	10.6	10.4	10.3
	Average	591	653	688	644	60.6	61.3	62.3	61.4	10.3	10.9	10.6	10.6
Jersey	Hereford	577	566	638	594	59.0	59.4	59.7	59.4	9.7	9.7	9.8	9.7
	Angus	557	580	610	582	60.4	60.3	59.9	60.2	10.5	10.8	10.5	10.6
	Average	567	573	624	588	59.7	59.8	59.8	59.8	10.1	10.3	10.1	10.2
South Devon	Hereford	586	653	743	661	61.0	61.3	61.4	61.2	10.7	9.6	11.0	10.4
	Angus	642	676	682	667	61.3	62.1	62.2	61.9	11.0	10.7	10.9	10.9
	Average	614	665	713	664	61.1	61.7	61.8	61.5	10.8	10.1	11.0	10.6
Limousin	Hereford	649	684	672	669	61.1	62.4	62.7	62.1	9.2	9.1	9.6	9.3
	Angus	614	685	688	662	60.7	62.3	62.0	61.7	9.7	9.3	9.6	9.5
	Average	632	685	680	665	60.9	62.4	62.3	61.9	9.4	9.2	9.6	9.4
Simmental	Hereford	628	674	739	681	59.2	60.3	61.0	60.2	9.5	10.1	9.5	9.7
	Angus	646	663	743	684	60.9	60.3	61.1	60.8	10.7	10.4	10.5	10.5
	Average	637	669	741	682	60.1	60.3	61.1	60.5	10.1	10.3	10.0	10.1
Charolais	Hereford	677	689	761	709	61.6	60.3	62.0	61.3	10.1	9.9	10.8	10.3
	Angus	619	688	740	682	60.1	62.5	62.6	61.7	10.3	10.9	11.1	10.8
	Average	648	689	750	696	60.9	61.4	62.3	61.5	10.2	10.4	10.9	10.5
Average	Hereford	613	648	700	653	60.5	60.7	61.3	60.9	10.0	10.0	10.2	10.1
All Sire	Angus	612	652	687	650	60.7	61.5	61.7	61.3	10.5	10.6	10.6	10.6
Breeds	Average	612	650	694	652	60.6	61.1	61.5	61.1	10.2	10.3	10.4	10.3

a Data for all carcass traits adjusted by regression on birthdate to the average age of each slaughter group, and adjusted for age of dam.

b U.S.D.A. Quality Grade: 9 = high good; 10 = low choice; 11 = average choice; 12 = high choice; etc.

Table 53. U.S. Meat Animal Research Center Germ Plasm Evaluation least squares means for yield grade, rib eye area, fat thickness, and percentages of kidney, pelvic, and heart fat[a].

		U.S.D.A. Yield Grade				Rib eye area, sq. in.				Fat thickness, in.				Estimated kidney, pelvic, and heart fat, %			
Breed of sire	Breed of dam	215	243	271	Avg.	215	243	271	Avg.	215	243	271	Avg.	215	243	271	Avg.
Hereford	Hereford	3.1	3.2	3.5	3.3	10.4	11.4	11.5	11.1	.50	.59	.65	.58	2.2	2.7	2.9	2.6
Angus	Angus	3.5	3.4	3.9	3.6	10.8	11.4	11.4	11.2	.61	.60	.87	.70	3.5	3.3	3.4	3.4
	Average	3.3	3.3	3.7	3.4	10.6	11.4	11.4	11.1	.56	.60	.76	.64	2.9	3.0	3.2	3.0
Angus	Hereford	3.2	3.5	3.6	3.4	11.0	11.7	12.3	11.6	.54	.67	.73	.65	3.2	3.3	3.2	3.2
Hereford	Angus	3.4	3.7	4.3	3.8	10.8	11.2	11.3	11.1	.61	.72	.89	.74	3.0	3.0	3.3	3.1
	Average	3.3	3.6	3.9	3.6	10.9	11.4	11.8	11.3	.57	.70	.81	.69	3.1	3.1	3.3	3.2
Jersey	Hereford	3.2	3.1	3.7	3.3	10.1	10.9	11.4	10.8	.31	.43	.52	.42	4.4	4.5	5.7	4.8
	Angus	3.5	3.3	3.7	3.5	10.5	11.1	10.9	10.8	.54	.51	.62	.56	4.6	4.6	5.1	4.8
	Average	3.3	3.2	3.7	3.4	10.3	11.0	11.1	10.8	.43	.47	.57	.49	4.5	4.6	5.4	4.8
South Devon	Hereford	2.8	3.1	3.6	3.2	11.8	11.5	11.9	11.8	.41	.47	.62	.50	3.4	3.4	4.1	3.6
	Angus	3.1	3.1	3.6	3.3	11.8	12.4	12.3	12.2	.53	.54	.68	.58	3.6	3.2	4.2	3.7
	Average	2.9	3.1	3.6	3.2	11.8	12.0	12.1	12.0	.47	.51	.65	.54	3.5	3.3	4.1	3.6
Limousin	Hereford	2.3	2.4	2.8	2.5	12.8	13.7	12.7	13.1	.37	.42	.56	.45	2.7	3.1	3.0	2.9
	Angus	2.4	2.6	2.7	2.6	12.2	13.1	13.3	12.9	.37	.49	.51	.46	2.8	3.4	3.3	3.2
	Average	2.3	2.5	2.8	2.5	12.5	13.4	13.0	13.0	.37	.46	.54	.46	2.8	3.2	3.1	3.1
Simmental	Hereford	2.4	2.6	2.8	2.6	11.9	12.5	13.2	12.5	.32	.42	.52	.42	2.8	2.9	2.9	2.9
	Angus	2.8	3.0	3.1	2.9	12.3	12.2	13.3	12.6	.46	.47	.53	.49	3.3	3.5	3.9	3.6
	Average	2.6	2.8	3.0	2.8	12.1	12.3	13.2	12.6	.39	.45	.53	.45	3.0	3.2	3.4	3.2
Charolais	Hereford	3.0	2.4	2.9	2.7	11.8	13.0	12.8	12.5	.42	.35	.42	.40	3.0	2.9	3.1	3.0
	Angus	2.5	3.0	2.8	2.8	11.6	12.8	13.8	12.7	.35	.49	.50	.45	2.7	3.6	4.0	3.4
	Average	2.7	2.7	2.8	2.8	11.7	12.9	13.3	12.6	.39	.42	.46	.42	2.8	3.3	3.6	3.2
Average	Hereford	2.8	2.9	3.3	3.0	11.4	12.1	12.2	11.9	.41	.48	.57	.49	3.1	3.3	3.6	3.3
All Sire	Angus	3.0	3.2	3.4	3.2	11.4	12.0	12.3	11.9	.50	.55	.66	.57	3.3	3.5	3.9	3.6
Breeds	Average	2.9	3.0	3.4	3.1	11.4	12.1	12.3	11.9	.45	.51	.62	.53	3.2	3.4	3.7	3.4

[a] Data for all carcass traits adjusted by regression on birth date to the average age of each slaughter group, and adjusted for age of dam.

Table 54. U.S. Meat Animal Researcn Center Germ Plasm Evaluation least squares means for cutability, retail product, fat trim, and bone percentages[a].

Breed of sire	Breed of dam	Cutability, %[b]				Retail product, %[c]				Fat trim, %				Bone, %			
		215	243	271	Avg.	215	243	271	Avg.	215	243	271	Avg.	215	243	271	Avg.
Hereford Angus	Hereford	52.1	51.2	49.9	51.4	65.5	64.9	61.6	64.1	20.9	22.3	25.9	22.9	13.6	12.8	12.6	13.0
	Angus	50.3	50.0	48.2	49.5	64.0	63.5	60.2	62.5	23.4	24.5	28.4	25.5	12.6	12.1	11.4	12.0
	Average	50.9	50.5	48.8	50.2	64.6	64.1	60.7	63.1	22.3	23.4	27.3	24.4	13.1	12.4	12.0	12.5
Angus Hereford	Hereford	51.6	51.3	50.5	51.1	65.4	63.8	62.8	64.0	21.7	23.7	25.2	23.6	12.8	12.5	11.9	12.4
	Angus	50.3	49.2	47.7	49.1	63.5	61.4	59.0	61.4	23.6	26.4	29.8	26.5	12.9	12.2	11.2	12.1
	Average	50.8	50.0	48.8	49.9	64.2	62.3	60.5	62.4	22.9	25.3	28.0	25.4	12.9	12.4	11.6	12.3
Jersey	Hereford	51.2	50.6	49.6	50.4	64.6	63.5	61.5	63.2	21.6	23.6	25.6	23.6	13.9	12.9	12.8	13.2
	Angus	48.6	49.8	48.8	49.1	61.3	62.5	60.9	61.5	26.1	25.1	26.7	26.1	12.6	12.4	12.3	12.5
	Average	49.4	50.1	49.1	49.6	62.4	62.9	61.1	62.1	24.3	24.4	26.3	25.1	13.2	12.7	12.6	12.8
South Devon	Hereford	52.7	53.6	49.5	52.1	65.7	67.1	61.0	64.8	20.1	19.9	26.0	21.8	14.2	13.0	13.0	13.4
	Angus	51.5	52.7	49.6	51.3	64.8	66.3	61.8	64.4	22.7	21.0	26.3	24.1	12.9	12.6	11.9	12.5
	Average	51.9	53.0	49.6	51.6	65.1	66.6	61.6	64.5	21.3	20.6	25.9	22.6	13.5	12.8	12.5	12.9
Limousin	Hereford	58.1	56.9	55.6	56.9	72.1	70.8	68.3	70.5	14.2	16.3	18.7	16.3	13.8	12.9	13.0	13.2
	Angus	58.2	56.1	54.9	56.3	72.6	70.1	67.7	70.0	13.5	17.2	19.8	17.0	13.9	12.7	12.5	13.0
	Average	58.2	56.5	55.2	56.6	72.3	70.5	68.0	70.3	13.8	16.8	19.3	16.6	13.8	12.8	12.7	13.1
Simmental	Hereford	56.4	54.5	54.8	55.2	70.7	68.0	67.8	68.8	14.6	18.2	18.5	17.1	14.7	13.8	13.7	14.0
	Angus	53.3	52.4	52.6	52.7	66.9	65.3	65.2	65.7	19.6	21.5	21.8	21.0	13.5	13.3	13.0	13.3
	Average	54.7	53.3	53.5	53.8	68.6	66.5	66.3	67.1	17.3	20.0	20.4	19.3	14.1	13.5	13.3	13.6
Charolais	Hereford	54.3	56.5	54.4	55.1	68.1	70.2	67.3	68.5	18.1	17.2	19.5	18.0	13.8	13.6	13.3	13.6
	Angus	55.2	53.7	54.2	54.3	69.1	67.2	67.1	67.8	16.5	20.2	20.4	19.1	14.4	12.6	12.5	13.2
	Average	54.8	54.9	54.3	54.6	68.7	68.5	67.2	68.1	17.2	18.4	19.9	18.6	14.1	13.1	12.9	13.4
Average All Sire	Hereford	54.2	54.6	52.6	53.8	67.7	68.2	65.0	67.0	18.5	18.7	22.1	19.8	13.8	13.1	12.9	13.3
	Angus	52.2	51.2	50.9	51.4	65.9	64.2	63.1	64.4	20.8	23.2	24.8	22.9	13.3	12.6	12.1	12.6
	Average	53.0	52.6	51.6	52.4	66.6	65.8	63.9	65.5	19.8	21.4	23.6	21.5	13.5	12.8	12.5	13.0

[a]Data for all carcass traits adjusted by regression on birth date to the average age of each slaughter group, and adjusted for age of dam.

[b]Cutability, % = Actual yield of boneless, closely trimmed beef from round, loin, rib, and chuck (lean trim adjusted to 25% fat content).

[c]Retail Product, % = Actual yield of boneless, closely trimmed beef from carcass (lean trim adjusted to 25% fat content).

Table 55. U.S. Meat Animal Research Center Germ Plasm Evaluation least squares means for Warner-Bratzler shear and taste panel evaluation of cooked steaks[a].

Breed of sire	Breed of dam	Warner-Bratzler shear, lb.[b]				Taste panel[c]: tenderness				Taste panel[c]: flavor				Taste panel[c]: juiciness				Taste panel[c]: acceptability			
		215	243	271	Avg.	215	243	271	Avg.	215	243	271	Avg.	215	243	271	Avg.	215	243	271	Avg.
Hereford Angus	Hereford	7.6	6.7	7.3	7.2	7.4	7.2	7.3	7.3	7.3	7.5	7.3	7.4	7.0	6.7	6.8	6.8	7.1	7.2	7.2	7.1
	Angus	7.1	6.4	6.3	6.6	7.3	7.9	7.1	7.4	7.5	7.6	7.4	7.5	6.7	7.3	6.4	6.8	7.3	7.6	7.1	7.3
	Average	7.3	6.5	6.8	6.9	7.4	7.5	7.2	7.3	7.4	7.5	7.4	7.4	6.8	7.0	6.6	6.8	7.2	7.4	7.1	7.2
Angus Hereford	Hereford	6.9	6.5	6.7	6.7	7.8	7.9	6.8	7.5	7.7	7.5	7.1	7.4	7.1	6.8	6.1	6.7	7.5	7.4	6.5	7.2
	Angus	8.0	6.7	7.0	7.3	6.9	7.0	7.6	7.2	7.2	7.2	7.9	7.4	6.9	6.2	7.2	6.8	7.0	6.9	7.6	7.2
	Average	7.5	6.6	6.8	7.0	7.4	7.5	7.2	7.4	7.4	7.4	7.5	7.4	7.0	6.5	6.6	6.7	7.3	7.2	7.1	7.2
Jersey	Hereford	7.1	5.9	6.2	6.4	7.5	7.8	7.2	7.5	7.3	7.6	7.6	7.5	6.7	6.7	7.3	6.9	7.2	7.5	7.3	7.3
	Angus	6.8	5.9	6.6	6.4	7.8	7.9	6.9	7.5	7.5	7.6	7.4	7.5	7.3	6.8	7.2	7.1	7.4	7.5	7.0	7.3
	Average	6.9	5.9	6.4	6.4	7.6	7.8	7.0	7.5	7.4	7.6	7.5	7.5	7.0	6.8	7.2	7.0	7.3	7.5	7.2	7.3
South Devon	Hereford	6.2	5.8	6.3	6.1	7.4	7.4	7.2	7.4	7.2	7.5	6.9	7.2	6.8	7.0	7.3	7.0	7.2	7.3	7.0	7.2
	Angus	6.2	6.6	6.2	6.3	8.1	7.4	7.7	7.7	7.7	7.1	7.5	7.4	7.2	7.0	7.1	7.1	7.6	7.0	7.6	7.4
	Average	6.2	6.2	6.3	6.2	7.8	7.4	7.5	7.5	7.4	7.3	7.2	7.3	7.0	7.0	7.2	7.1	7.4	7.1	7.3	7.3
Limousin	Hereford	7.5	7.6	7.7	7.6	7.0	6.7	6.5	6.8	7.2	7.6	7.6	7.5	7.1	6.7	7.0	6.9	7.1	6.8	7.0	6.9
	Angus	6.7	7.5	7.0	7.1	7.8	7.0	6.8	7.2	7.4	7.0	7.4	7.3	7.4	6.5	6.7	6.9	7.5	6.9	7.0	7.1
	Average	7.1	7.6	7.3	7.3	7.4	6.9	6.7	7.0	7.3	7.3	7.5	7.4	7.2	6.6	6.8	6.9	7.3	6.8	7.0	7.0
Simmental	Hereford	8.3	7.1	7.2	7.5	6.1	7.5	6.7	6.8	7.1	7.9	7.5	7.5	7.1	7.1	7.2	7.1	6.6	7.6	7.0	7.0
	Angus	7.2	7.4	6.7	7.1	7.8	7.2	7.6	7.5	7.8	7.8	7.5	7.7	7.6	7.4	7.2	7.4	7.7	7.4	7.3	7.5
	Average	7.8	7.2	6.9	7.3	6.9	7.3	7.1	7.1	7.5	7.8	7.5	7.6	7.3	7.3	7.2	7.3	7.1	7.5	7.2	7.2
Charolais	Hereford	7.5	7.2	6.7	7.1	7.7	6.7	7.4	7.3	7.3	7.3	7.7	7.4	7.0	6.5	7.3	6.9	7.2	7.4	7.4	7.3
	Angus	7.3	6.0	6.9	6.7	7.5	7.4	7.5	7.5	7.3	7.6	7.8	7.6	7.2	6.6	7.2	7.0	7.2	7.3	7.5	7.3
	Average	7.4	6.6	6.8	6.9	7.6	7.1	7.4	7.4	7.3	7.5	7.8	7.5	7.1	6.5	7.2	6.9	7.2	7.3	7.5	7.3
Average All Sire Breeds	Hereford	7.3	6.7	6.9	7.0	7.3	7.3	7.0	7.2	7.3	7.6	7.4	7.4	7.0	6.8	7.0	6.9	7.1	7.3	7.0	7.2
	Angus	7.0	6.6	6.7	6.8	7.6	7.4	7.3	7.4	7.5	7.4	7.6	7.5	7.2	6.8	7.0	7.0	7.4	7.2	7.3	7.3
	Average	7.2	6.7	6.8	6.9	7.4	7.4	7.2	7.3	7.4	7.5	7.5	7.5	7.1	6.8	7.0	7.0	7.3	7.3	7.2	7.2

[a]Data for all carcass traits adjusted by regression on birth date to the average age of each slaughter group, and adjusted for age of dam.

[b]Measure of pounds of force required to shear one-half inch cores of steaks cooked at 350°F to 150°F internal temperature and cooled for 30 minutes at room temperature. Warner-Bratzler shear values were obtained on steaks from all 425 steers.

[c]Taste panel scores based on a 9-point scale, with higher scores indicating greater acceptability. Taste panel traits measured on steaks from 4 steers per breed group per slaughter date (168).

Table 56. U.S. Meat Animal Research Center Germ-Plasm Evaluation postweaning growth and reproductive performance of heifers.

Breed of sire	Breed of dam	No. of heifers	200-day postweaning avg. daily gain, lb.	Adj. 400-day wt., lb.[a]	Adj. 550-day wt., lb.[b]	% reaching puberty by 15 mos.	Avg. age at puberty, days[c]	% pregnant[d]
Hereford	Hereford	27	0.91	598	658	48	390	67
Angus	Angus	24	1.13	660	683	92	372	80
	Average	51	1.02	629	670	69	381	74
Angus	Hereford	23	1.13	657	704	83	371	87
Hereford	Angus	23	1.14	678	737	91	351	96
	Average	46	1.13	668	721	87	361	92
Jersey	Hereford	29	0.96	615	665	97	319	93
	Angus	16	0.99	613	657	100	324	88
	Average	45	0.98	614	661	98	322	91
South Devon	Hereford	18	1.10	657	721	72	371	67
	Angus	18	1.28	709	740	100	358	78
	Average	36	1.19	683	730	86	365	73
Limousin	Hereford	33	1.02	651	710	42	359	68
	Angus	25	1.14	695	751	96	358	88
	Average	58	1.08	673	730	69	359	78
Simmental	Hereford	28	1.13	688	746	71	369	71
	Angus	22	1.22	718	761	100	360	91
	Average	50	1.18	703	753	86	365	81

(continued on next page)

Table 56. (continued)

Breed of sire	Breed of dam	No. of heifers	200-day postweaning avg. daily gain, lb.	Adj. 400-day wt., lb.[a]	Adj. 550-day wt., lb.[b]	% reaching puberty by 15 mos.	Avg. age at puberty, days[c]	% pregnant[d]
Charolais	Hereford	35	1.09	687	746	83	366	78
	Angus	16	1.22	722	796	88	371	75
	Average	51	1.15	704	771	85	369	77
Average All Sire Breeds	Hereford	193	1.04	651	707	71	362	75
	Angus	144	1.16	686	733	95	356	85
	Average	337	1.10	668	720	83	359	80

[a]Adjusted 400-day weight = Adjusted 200-day weight + (200-day postweaning average daily gain x 200 days).

[b]Adjusted 550-day weight = Adjusted 200-day weight + (350-day postweaning average daily gain x 350 days), shrunk weight.

[c]Includes only heifers reaching puberty by 15 months, and should be interpreted in relation to the percentage reaching puberty by 15 months.

[d]Breeding period was 45 days by artificial insemination (May 24 to July 7) and 26 days by natural service (July 8 to August 2).

Meat Shrinkage

Jerry Leising and Harold Tuma

Introduction

Meat shrinkage is a major problem for the beef industry. Shrinkage (loss in weight) results from many factors: improper chilling, low humidity, not packaging, poor sanitation, or excessive ageing time. Most beef is chilled overnight (16-20 hrs.) at cooler temperatures of 25 to 40°F. Internal temperatures after 20 hours chill vary from 55° to 70°F depending on cooler conditions and carcass weight. During a normal chill cycle, beef carcasses shrink 6 to 12 pounds or 1-2% for 600-pound carcass with the shrink depending on many cooler and carcass factors. Various methods have been used to reduce moisture evaporation (shrink) by protecting the meat with a bag or wrapper and by controlling temperature and relative humidity. Information is limited concerning optimum chilling conditions for maximum cooling efficiency with minimum shrinkage.

Materials and Methods

We studied variables that affect shrinkage and effects of carcass weight and fat thickness on cooling rates.

Seventy-two beef carcasses from three different Kansas packing companies (A, B, and C) were used. Carcasses were selected at random for weight and fat thickness before washing and shrouding. Weight groups of 550, 650, and 750 and fat thickness of 0.2", 0.5", and 0.75" between the 12th and 13th ribs were used.

Carcass temperatures were recorded continuously during the chill period by a Honeywell Electronik-16 Potentiometer. Temperatures were recorded from both the deep of the round (8" deep) and the deep of the chuck (under the scapula), as was cooler temperature. Relative humidity recordings were taken during the chill cycle by a Hygro-thermograph. Air velocity was measured with a Hastings RB-1 air meter in cooler locations. At each location readings were taken above, below, and between carcasses. Shrinkage for each carcass was determined by collecting hot carcass weight before washing and shrouding minus chilled weight without shroud. Shrinkage data were collected at 24 and 48 hours.

Results and Discussion

Significant differences were found in carcass shrinkage in all coolers A, B, and C. Shrinkage values after 24 hours were: A = 1.49%, B = 1.29%, and C = 2.13%. Differences between weight groups were significant (table 57).

Shrinkage of light (550 lbs.) and medium (650 lbs.) carcasses was significantly ($P < .05$) less in coolers A and B than in cooler C. Shrinkage of heavy carcasses (750 lbs.) also differed significantly among coolers A, B, and C. Cooler C was the least efficient; cooler B was most efficient.

Cooler B maintained both the lowest cooler temperature (34.7°F) and relative humidity of (61.0) percent. Cooler C varied the most in air temperature during the chill cycle. Its average air temperature was (38.0°F); relative humidity, (82.0) percent. Cooler C shrinkage was comparatively high for a 24-hour chill. The higher shrinkage in cooler C might be explained by warmer temperatures and slower chill rate. Shrinkage in cooler A was slightly higher and its temperature (35.6°F) slightly higher than they were in cooler B. Air velocity averaged 169 ft. per min., in cooler A, 97 ft. in cooler B, and 95 ft. per min. in cooler C. Differences in air velocities between coolers A and B may explain the slightly greater shrinkage in cooler A. Cooler B's lower relative humidity otherwise would indicate more shrinkage in B than in A. Most published data indicate lower relative humidities increase shrinkage. Relative humidity's importance may vary with cooler temperatures and air velocities. However, low relative humidity is advantageous for meat color, bloom, general appearance, and absence of surface slime.

Summary

Cooler temperatures should be held constant at approximately 32° with average relative humidity 80-90%, and cooler air evenly distributed at a velocity of 120-147 ft. per min. Fat thickness had no significant effect on carcass shrinkage. Carcass weight significantly affected total shrinkage with 550 lb. carcasses shrinking 1.77% and 750 lb. carcasses 1.54%. After 20 hours internal chuck temperatures were 45 to 55°F, internal round, from 55 to 65°F. Significant differences were found among coolers A, B, and C.

Table 57. Meat shrinkage in coolers by indicated weight groups.

Cooler	Carcass weight groups 550	650	750	Pooled for coolers
	(%) shrinkage 24 hours			
A	1.50	1.39	1.57	1.49[a]
B	1.26	1.30	1.29	1.29[b]
C	2.54	2.09	1.76	2.13[c]
Pooled by weight groups	1.77[a]	1.59[b]	1.54[b]	

[abc]Mean with different superscripts differ significantly. ($P < .05$).

KSU

Kansas Meat Marketing Innovations

Farrell E. Jensen, Donald B. Erickson,
S. E. Trieb, and Harold J. Tuma[1]

The U. S. system of producing, marketing, and distributing farm products has been heralded as the world's most efficient, with lower distribution costs than any other nation. Research continues to improve marketing through new methods and technology. Central cryogenic-frozen meat packaging is an example.

Research in central cryogenic-frozen meat packaging was conducted by a team in the Kansas Agricultural Experiment Station. Staff members participated from the Departments of Agricultural Economics, Animal Science and Industry, Foods and Nutrition, Statistics and Computer Science, and Agricultural Engineering. Funds were obtained from the U. S. Department of Agriculture, the Kansas Agricultural Experiment Station, and from several companies interested in the meat industry.

Market Test of Centrally Packaged and Cryogenically Frozen Meat

Objectives were to determine the nature of decision making regarding buying fresh or frozen retail cuts, and whether or not consumers would buy frozen retail cuts packaged and sold as identical fresh cuts were. Savings in market costs could have considerable impact on the Kansas cattle feeding and packing industries. If frozen meat satisfies consumers, Kansas feeders and meat packers could save on transportation to distant markets.

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[1] Farrell E. Jensen, Graduate Research Assistant, Department of Agricultural Economics, Donald B. Erickson, Associate Professor, Department of Agricultural Economics, Sykes E. Trieb, Professor, former member of the Department of Agricultural Economics (currently Head, Extension Marketing, University of Georgia), and Harold J. Tuma, Associate Professor, Department of Animal Science and Industry.

In the test, frozen meat was sold 13 weeks in two types of retail stores in New Jersey and Pennsylvania: high volume supermarkets and service-oriented convenience stores. Three types of packages were used: (1) frozen meat in cartons, (2) frozen meat in clear film with both sides visible, and (3) identical fresh meat cuts in overwrap trays.

Sales data and daily purchase patterns were recorded and questionnaires were administered to selected consumers who maintained daily purchase diaries during the test. Following the sales test, interviews were conducted on what customers want when they shop for meat.

Meat used in the tests was packaged in clear see-through film attached to a headerboard to allow total product visibility. The film conformed to the exact contour of the meat and prevented frost pockets and ice crystals from forming. Consumers were offered a wide range of frozen meat: 26 cuts of beef, pork, and lamb. Frozen meats were displayed in the center of meat cases next to identical fresh cuts. Frozen cuts were priced the same, higher, and lower than identical fresh cuts. The meat was frozen cryogenically (using inert nitrogen) at 75°F below zero, for a bright red, natural color. The test meat competed objectively for consumer acceptance.

Results

The average package market share for the frozen meat compared to the identical fresh cuts was 15.6% and 19.2% at the two supermarkets. Sixty-two percent of a sample of panelists purchased the frozen meat, and 83 percent of them said "it measured up" to their expectations; 45% liked the frozen meat's good flavor and 27.2%, its tenderness.

Over half (54.3%) said they "had no complaints." Product dissatisfaction by some consumers included lack of tenderness (12.4%), inconvenience (11.6%), and unattractiveness (11.6%).

The flavor of the test product was considered equal to fresh meat by 54.9% and better than fresh meat by 18% of the panelists; 27% considered the fresh product's flavor "better".

The majority of respondents considered frozen meat to have less waste (it and fresh meat were trimmed to the identical specifications). Most frequent suggestions to improve the frozen cuts were related to packaging and merchandising. Typical comments referred to package size, appearance (artificial, unappetizing), price, and lack of a variety of cuts.

Statements indicating equal acceptability for both fresh and frozen cuts were made by 43.2% of the respondents. Fresh meat was rated "better" in over-all characteristics by 32.8% while 24% considered the frozen product better.

Purchasers of the test meat listed tenderness, juiciness, and flavor as the most important factors they considered when buying fresh or frozen meat. Nonpurchasers listed the same factors for fresh meat but were more concerned with quality, attractiveness, amount of bone and fat, and freshness of frozen meat.

A high percentage (82.8%) of the respondents were favorably impressed with the packaging because they could "see both sides" of the meat. Criticism of frozen packaging centered around inconvenience in handling the header board, the meat's artificial appearance, and the inconvenience of storing frozen cuts (because of header board).

Implications

There are at least eight changes that encourage alternative marketing patterns now.

1) The development of new "skin tight" packaging materials.

2) Cryogenic freezing methods with more desirable packaging.

3) Consumer acceptance of see-through, clear packaging.

4) Natural product color and shape with freedom from frost and ice on meat and package surfaces.

5) Attitudes of retailers seeking ways to improve retail meat operations.

6) Fewer waste disposal problems in areas of highly concentrated populations.

7) Adaptability of frozen meats to neighborhood convenience stores (fastest growing in the food industry), and the 10,000 to 20,000 square foot supermarkets.

8) Increased shelf life of frozen meat in low-volume stores.

Considerations for Possible Future Application of Meat-distribution-and-processing Technology and Logistics

1) Meat department productivity (sales per man hour) has remained nearly constant at 50 to 60 pounds per man hour, while labor costs have increased 5% to 10% per year.

2) Qualified meat cutters, especially on the east coast, are in short supply.

3) The meat department is not a profit leader. Average direct profit reported by other studies was only 5.5% before store and general overhead expenses which reduced net profit to or near 0%.

4) Central packaging, near feedlots for shipment of retail-ready merchandise to distant markets could increase efficiency as well as help reduce environmental problems disposing of bone and fat waste creates in population centers.

5) Union attitudes toward central processing have softened recently.

Seeking Efficiencies

Store types in the food retailing industry are dominated by different philosophies of merchandising. The high-service, convenience store, with long hours, low volume, and higher gross margins (22-26%) is at the "service" end, while the low-service warehouse retailer with shorter hours, high volume and lower gross margins (10-15%) is at the "no service end." Between them are food discounters, supermarkets, new delivery system retailers, and vending operations.

People will seek to concentrate their once-a-week shopping in the large full line stores while using the quick-serve, 16- to 24-hour convenience stores for fill-in needs. Merchandise requirements for both types of stores indicate that today's perishable products, especially meats and produce, will change drastically, so frozen meat marketing may increase significantly.