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**DRIED CITRUS PULP IN  
BEEF CATTLE FATTENING RATIONS**

J. M. JONES, R. A. HALL  
E. M. NEAL, J. H. JONES

Division of Range Animal Husbandry



AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS  
T. O. WALTON, President

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When dried citrus pulp was fed to replace 25 percent of the daily allowance of ear corn chop with husk in fattening rations for beef steers resultant gains and finish were practically the same as for the corn alone. When it was fed to replace as much as 59 percent, the consumption of feed, gain in weight, and the finish were reduced. The ration containing 45 to 60 percent of dried citrus pulp was less palatable and had slightly greater laxative effect than the ration containing the smaller amount.

The dried citrus pulp, a by-product of a grapefruit juice cannery, consisted almost entirely of grapefruit peel, rag, and seed.

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## DRIED CITRUS PULP IN BEEF CATTLE FATTENING RATIONS

J. M. Jones, R. A. Hall, E. M. Neal, J. H. Jones\*

The use of dried citrus fruit by-products for livestock feeding was first suggested in 1916 (1). Subsequent work by the Florida (2 & 3) and California (4 & 5) Experiment Stations has shown that dried grapefruit cannery refuse and dried orange peel are in the class of high carbohydrate concentrate feeds, and furthermore that cattle will eat these products.

In a digestion trial with dried grapefruit refuse with 4 steers, Neal (1) at the Florida Station found 24.8 percent of the crude protein, 71.5 percent of the crude fiber, 92.4 percent of the nitrogen free extract, and 79.4 percent of the crude fat to be digestible. The dried grapefruit used yielded 1.2 percent digestible protein and 76 percent total digestible nutrients and was palatable. Neal (1) also noted that dried orange peel seemed to be as palatable as dried grapefruit refuse and that dried grapefruit and orange cannery refuses have a laxative action when fed as a large proportion of the ration. The general effects of the dried grapefruit refuse were noted as being favorable as indicated by thrifty appearance, gloss of the coat of hair, and improvement in thickness of flesh.

In later work, Arnold, Becker, and Neal at the Florida Station (2) found that dried grapefruit pulp was palatable to dairy cows and that no flavor characteristic of that product occurred in the milk during the feeding trials in question. They also observed that Florida dairymen have fed a considerable quantity of fresh citrus pulp to dairy cows and heifers and that the fermenting product tended to impart a slight flavor to the milk. Grapefruit pulp ensiled with grass by a Florida cattleman produced a fair quality of silage; however, the cattle utilizing this feed showed preference for the ensiled rag and seed rather than the peel.

Processors in the Lower Rio Grande Valley of Texas faced with the problem of disposing of citrus cannery refuse and with the available information in regard to the feeding value of dried citrus products, began to prepare dried citrus pulp in 1937. The estimated average tonnage produced by years since that time is as follows: 1937-38, 9400 tons; 1938-39, 10,200 tons; 1939-40, 2700 tons, and 1940-41, 8000 tons. When this product, which to date in Texas has consisted of approximately 85 and 15 percent, respectively, of grapefruit and orange peel and rag, appeared on the Texas market, questions arose as to its feeding value. The Texas Station accordingly began work to determine the feeding value of the product. Expensive to dehydrate and distribute, the manufacturers

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\*Chief, Division of Range Animal Husbandry; Superintendent, Substation No. 1, Beeville; Animal Husbandman, Substation No. 1, Beeville; and Animal Husbandman, Division of Range Animal Husbandry, respectively.

wished to know whether the dried citrus pulp had high enough feed value to offset the cost of preparation. Feeders wished to know its value in comparison to other available carbohydrate feeds such as ear corn chop with husk.

### General Plan of Experiment

Since dried citrus pulp is known to be a feed high in carbohydrates, it was logical to compare it with a grain feed in order to determine the comparative price which the feeder can afford to pay for the citrus pulp. Ear corn chop with husk was selected for the comparison since it was readily available in the region and since it has a content of crude fiber and nitrogen free extract quite similar to that of dried citrus pulp. Believing also that dried citrus pulp to a certain extent lacked palatability, it was fed as a replacement for ear corn chop with husk in fattening rations (1) in moderate amount, and (2) in as large amount as would be readily consumed. The experiment involved three separate feeding trials conducted during three consecutive years, 1937-38, 1938-39, and 1939-40. The results are presented separately by years then brought together in the form of a summary.

Three lots of feeder steers were used in each of the three feeding trials. The averages of three initial and three final individual weights secured on consecutive days constituted the initial and final weights of the lots. The lots were formed, after the third initial weighing, as equally as possible, with reference to weight and type. Individual weights were taken at 28-day intervals in regular manner. Records of all feeds fed and consumed were obtained; also notes in regard to the day to day appetite and condition of the steers were recorded.

The plan in feeding was as follows:

Lot 1, (check), ear corn chop with husk, cottonseed meal, roughage, and pulverized limestone or pulverized oyster-shell.

Lot 2, same as Lot 1, except that 25 per cent of the ear corn chop with husk was replaced by dried citrus peel and pulp.

Lot 3, same as Lot 1, except that as much of the ear corn chop with husk was replaced by dried citrus pulp as would, in the judgment of the feeder, be consumed.

Each year the steers were fed with the idea of fattening them as quickly as practicable and the ear corn chop with husk and mixtures of dried citrus pulp were increased as rapidly as could be done without getting the steers off feed. The cottonseed meal was fed in a regular amount from start to close of the feeding period. All of the feeds were mixed together and were given twice daily, about 8 a. m. and 5 p. m., and in such amount as to result in only slight refusal of the less palatable portions. The percentage of dried citrus pulp fed to Lot 3 varied for the different years and this variation is described for each feeding trial.

### Cattle Used

Twenty-four head of good to medium grade Hereford yearling steers produced in the Beeville area were used in the first feeding trial, a period of 140 days, December 9, 1937, to April 28, 1938. These steers were in medium flesh and weighed an average of 621 pounds per head when started on feed.

Thirty head of 555 pound good to choice grade Hereford steer calves purchased in Llano County were used in the second feeding trial, a period of 168 days, November 16, 1938, to May 3, 1939. These calves were in good flesh when started on feed.

For the third trial of 154 days, December 20, 1939 to May 22, 1940, 30 head of medium to good grade Hereford steer calves were secured in the Corpus Christi area. These calves were received October 30, and were dehorned at that time. After dehorning they were pastured and fed for 51 days before the start of the test, and in this period they gained 96 pounds per head. They entered the test at an average weight of 536 pounds per head and were in good condition as shown in Figure 1.

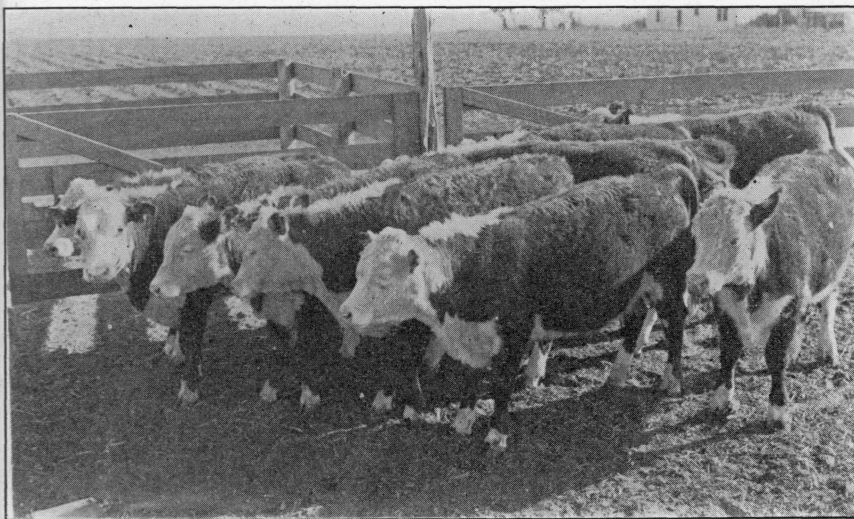


Figure 1. Representative Lot of Feeder Steer Calves (1939-40 trial).

### Feeds Used

The dried citrus pulp used was prepared at Weslaco. It consisted almost entirely of grapefruit peel, rag and seed, a by-product of a grapefruit juice cannery. It was of good quality, light brown in color, and as used in these tests was somewhat coarser than the ear corn chop with husk. Dried citrus pulp is offered on the market in different degrees of fineness; however, in this test the product was in the form of medium

to fine "cake" rather than finely ground. Most of the ear corn used was purchased locally and was of a white variety. It was ground with the husk and is referred to here as ear corn chop with husk. The cottonseed meal used was purchased under a guarantee of 43 percent protein content. The bulk of the roughage which was fed consisted of hegari silage produced on the station. A limited amount of cottonseed hulls was fed during the first trial. Either pulverized limestone or pulverized oyster-shell was used as a calcium supplement in each trial and a good grade of granulated salt was fed free choice. Table 1 shows the values in chemical composition which were used in the calculations involving the productive value of the dried citrus pulp. Samples of the dried citrus pulp and of the ear corn chop with husk were analyzed in 1937-38 and 1938-39. Sample of hegari silage, cottonseed meal, and cottonseed hulls were

**Table 1. Percentage Composition of Feeds Used in Experiment\***

Kind of feed	Year	Protein	Fat	Crude fiber	Nitrogen-free extract	Water	Ash
Dried citrus peel and pulp-----	{ 1937-38	6.15	3.65	10.43	61.93	10.18	7.66
	{ 1938-39	5.60	1.83	11.16	60.95	11.16	8.83
Ear corn chop with husk-----	{ 1937-38	8.40	3.11	11.00	64.03	11.54	1.92
	{ 1938-39	8.75	3.07	11.47	66.21	8.52	1.98
	{ †	8.7	3.2	10.0	66.6	9.6	1.9
Cottonseed meal-----	{ 1937-38	42.00	7.32	10.28	27.18	7.79	5.43
	{ †	43.2	7.5	10.8	26.2	6.8	5.5
Hegari silage-----	{ 1937-38	2.55	0.90	6.65	21.22	65.93	2.75
	{ †	2.5	0.90	6.3	18.8	67.2	4.3
Cottonseed hulls-----	{ 1937-38	3.69	0.87	47.49	33.74	11.22	2.99
	{ †	4.1	0.9	47.6	35.3	9.4	2.7

\*Analyses by Division of Chemistry, Texas Agricultural Experiment Station.

†Average analyses from Texas Station Bulletin 461.

analyzed only in 1937-38. The productive values for the ear corn chop with husk, hegari silage, cottonseed meal and cottonseed hulls were calculated from these analyses according to the digestion coefficients and the method shown by Fraps (2). According to the analyses the dried citrus pulp used in 1937-38 was superior to that used in 1938-39. When the total digestible nutrients for the dried citrus pulp used in the two years are calculated from the digestion coefficients determined by Neal (1) it is found that the feed used in 1937-38 contained 69.1 percent T.D.N. while that used in 1938-39 contained 67.2 percent. The calculated productive values of the ear corn chop with husk in therms per 100 pounds was 70.1 therms for 1937-38 and 72.2 therms for 1938-39.

### Feed Prices

The feed prices shown in Table 2 except for dried citrus pulp were the estimated average of the prices prevailing for the feeds during each of the three feeding trials. Since dried citrus pulp and the ear corn chop



**Table 2. Feed Prices Per Ton**

Feeds	1937-38	1938-39	1939-40
Ear corn chop with husk.....	\$20.00	\$13.00	\$24.00
Dried citrus pulp.....	20.00	18.00	24.00
Cottonseed meal.....	27.00	27.00	35.00
Silage, Hegari.....	4.00	3.00	3.00
Hegari stover.....			8.00
Cottonseed hulls.....	5.00		
Pulverized limestone or oyster shell.....	15.00	17.00	10.00
Granulated salt.....	17.00	15.00	12.00

with husk were compared on a replacement basis, both feeds were charged to the steers at the same price.

### Experimental Results

Gains, finish, carcass grade, and net financial return are factors considered in arriving at the comparative desirability of the ear corn chop with husk and dried citrus pulp used as fattening feeds. The productive value of the dried citrus pulp in comparison to the ear corn chop with husk is calculated in each trial. The palatability of the dried citrus pulp, the condition of the droppings, and the coat of hair in all lots are likewise noted. Table 3 shows the average rations by 28-day periods fed to the respective groups in each of the three experiments.

Table 3. Average Rations in Pounds Consumed by 28-Day Feeding Periods<sup>1</sup>

Lot	Year	Ration	1st 28 days	2nd 28 days	3rd 28 days	4th 28 days	5th 28 days	6th† 28 days	Average	
1.	1937-38*	Corn-----	7.70	11.40	11.47	14.21	16.00	-----	12.16	
		Cottonseed meal-----	2.50	2.61	2.93	3.00	3.00	-----	2.81	
		Hegari silage-----	24.55	12.12	9.30	6.99	4.38	-----	11.47	
	1938-39	Corn-----	4.98	7.80	11.80	14.12	15.31	16.9	11.80	
		Cottonseed meal-----	2.23	2.50	2.50	2.50	2.50	2.47	2.46	
		Hegari silage-----	23.38	20.95	17.70	13.10	8.10	5.70	14.80	
	1939-40	Corn-----	6.73	8.60	11.90	15.10	16.90	17.50	12.35	
		Cottonseed meal-----	2.30	2.50	2.50	2.50	2.45	2.39	2.44	
		Hegari silage-----	16.10	13.80	13.40	9.30	6.20	3.00	10.97	
	2.	1937-38*	Corn-----	5.77	8.80	8.60	10.65	12.05	-----	9.18
			Cottonseed meal-----	2.50	2.63	2.93	3.00	3.00	-----	2.81
			Citrus feed-----	1.92	2.90	2.87	3.55	4.02	-----	3.05
Hegari silage-----			24.22	12.54	9.30	6.99	4.54	-----	11.52	
1938-39		Corn-----	3.74	5.90	8.80	10.49	11.48	12.61	8.80	
		Cottonseed meal-----	2.28	2.50	2.50	2.50	2.50	2.48	2.46	
		Citrus feed-----	1.25	2.00	2.90	3.50	3.83	4.20	2.95	
		Hegari silage-----	23.46	20.92	17.70	13.10	8.06	5.72	14.80	
1939-40		Corn-----	5.00	6.40	8.90	11.10	12.40	13.00	9.16	
		Cottonseed meal-----	2.30	2.50	2.50	2.50	2.44	2.39	2.44	
		Citrus feed-----	1.70	2.20	3.00	3.70	4.10	4.30	3.05	
		Hegari silage-----	16.10	13.80	13.20	8.90	6.20	3.10	10.85	
3.	1937-38*	Corn-----	5.77	7.49	5.74	6.99	7.59	-----	6.72	
		Cottonseed meal-----	2.50	2.60	2.93	3.00	3.00	-----	2.81	
		Citrus feed-----	1.93	4.05	5.74	7.22	2.26	-----	5.44	
		Hegari silage-----	24.89	11.98	9.30	6.99	4.55	-----	11.55	
	1938-39	Corn-----	2.49	3.90	5.00	4.97	4.90	4.96	4.37	
		Cottonseed meal-----	2.28	2.50	2.50	2.50	2.50	2.48	2.45	
		Citrus feed-----	2.49	3.90	6.50	7.65	8.42	8.92	6.32	
		Hegari silage-----	23.33	20.87	17.55	12.99	8.10	5.72	14.76	
	1939-40	Corn-----	3.40	4.20	5.00	4.90	4.80	4.60	4.49	
		Cottonseed meal-----	2.30	2.50	2.50	2.50	2.48	2.29	2.42	
		Citrus feed-----	3.1†	4.20	6.00	7.70	9.40	9.60	6.43	
		Hegari silage-----	15.20	13.70	10.90	8.20	6.20	3.00	10.13	

\*3.17 pounds cottonseed hulls fed daily in addition to feeds shown, 1937-38.

†Only 14 days in sixth period for 1939-40.

‡Ear corn chop with husk fed in each test.

§One-tenth pound pulverized limestone or oyster shell per head daily was fed.

### Results 1937-38

The 24 head of Hereford yearling steers used in 1937-38 were divided into three comparable groups of 8 head each and were fed for a 140-day period on fattening rations as follows:

Lot 1 (check), ear corn chop with husk, cottonseed meal, hegari silage, cottonseed hulls, and pulverized oyster-shell.

Lot 2, same as Lot 1, except that 25% of the ear corn chop with husk was replaced by dried citrus pulp.

Lot 3, same as Lot 1, except that 45% of the ear corn chop with husk was replaced by dried citrus pulp.

The steers were fed with the idea of fattening them as quickly as practicable and the concentrates were held at the same level in all lots.

In Lot 2 the dried citrus pulp was fed throughout to replace 25% of the daily allowance of the ear corn chop with husk. In Lot 3 the dried citrus pulp was started at 25% and the average percentages fed by periods were in order 25%, 35%, 50%, 51% and 52% with an average of 45% for the entire 140-day feeding period. A summary of the feeding trial is shown in Table 4.

**Table 4. Summary First Feeding Trial December 9, 1937, to April 28, 1938—140 Days**

Lot number -----	1	2	3
Number of steers-----	8	8	8
Variables in feeding-----	Corn	25% citrus 75% corn	45% citrus 55% corn
Averages per Steer			
Initial weight, lbs.-----	622	620	622
Final weight at feedlot, lbs.-----	899	908	905
Final weight at San Antonio market, lbs.-----	850	858	856
Gain basis feedlot weight, lbs.-----	277	288	283
Gain basis market weight, lbs.-----	228	238	234
Daily gain basis feedlot weight, lbs.-----	1.98	2.06	2.02
Daily gain basis market weight, lbs.-----	1.63	1.70	1.67
Shrinkage enroute market, percent-----	5.45	5.51	5.41
Slaughter data			
Carcass weight (hot), lbs.-----	520	533	536
Dressing % basis hot carcass & market weight-----	61.2	62.1	62.6
Dressing % basis hot carcass & feedlot weight-----	57.8	58.7	59.2
Carcass grades (approximate)			
Strictly good to choice-----	5	3	3
Top medium to good-----	2	1	5
Medium-----	1	4	0
Feed consumed			
Ear corn chop with husk, lbs.-----	1762	1285	940
Dried citrus pulp, lbs.-----	-----	427	761
Cottonseed meal, lbs.-----	393	393	393
Hegari silage, lbs.-----	1618	1613	1616
Cottonseed hulls, lbs.-----	443	445	444
Salt, lbs.-----	4.46	4.50	5.75
Pulverized oyster shell, lbs.-----	14	14	14
Average rations			
Ear corn chop with husk, lbs.-----	12.16	9.18	6.72
Dried citrus pulp, lbs.-----	-----	3.05	5.44
Cottonseed meal, lbs.-----	2.81	2.81	2.81
Hegari silage, lbs.-----	11.47	11.52	11.55
Cottonseed hulls, lbs.-----	3.16	3.18	3.17
Salt, ounces-----	.51	.51	.66
Pulverized oyster shell, lb.-----	.10	.10	.10
Feed consumed per cwt. gain basis feedlot weight			
Ear corn chop with husk, lbs.-----	614	446	332
Dried citrus pulp, lbs.-----	-----	148	269
Cottonseed meal, lbs.-----	142	137	139
Hegari silage, lbs.-----	584	560	571
Cottonseed hulls, lbs.-----	100	154	157
Cost of feed per cwt. gain (feed consumed)			
Basis feedlot weight-----	\$ 9.68	\$ 9.35	\$ 9.47
Basis market weight-----	11.76	11.31	11.46
Financial statement			
Initial cost at \$7.25 per cwt.-----	\$45.10	\$44.95	\$45.10
Feed cost (feed consumed)-----	26.82	26.92	26.81
Marketing cost at \$.33 per cwt.-----	2.81	2.83	2.82
Total cost (not including labor)-----	74.73	74.70	74.73
Amount received at \$.80 per cwt.-----	74.80	75.50	75.33
Net return-----	.07	.80	.60

The ration fed to Lot 2 in which the dried citrus pulp replaced 25 percent of the ear corn chop with husk was fully as palatable as the ration fed to Lot 1. The ration fed to Lot 3 was palatable also, and the steers in both Lots 2 and 3 shed earlier and were more desirable in hair coat than the steers in Lot 1.

Lots 2 and 3 had slight advantage in gain and dressed yield. It was not possible to distinguish any difference in the color of fat between the lots but Lot 1 carcasses were rated as being more thickly and uniformly covered than the carcasses of Lots 2 and 3.

Based on a productive value of 70.1 therms per 100 pounds for the ear corn chop with husk the productive value for the dried citrus pulp fed to Lot 2 was 79.3 therms, while that fed to Lot 3 was 73.2 therms on basis of feedlot gains.

At the same price per ton for the ear corn chop with husk and the dried citrus pulp it was profitable to include the dried citrus pulp in the ration.

### Results 1938-39

The 30 head of good to choice Hereford steer calves used in 1938-39 were divided into three groups of 10 each, and were fed according to the same plan as the yearling steers used in 1937-38, except that Lot 3 was fed a larger percentage of dried citrus pulp. Lot 2 was again fed dried citrus pulp to replace 25 percent of the ear corn chop with husk. Lot 3 was fed a mixture of equal parts of the citrus and corn feeds during the first 56 days. During the last four 28-day periods 57 percent, 62 percent, 63 percent, and 64 percent of the ear corn chop with husk was replaced with the dried citrus pulp. For the entire 168-day feeding period an average of 59 percent of the ear corn chop with husk was replaced with the dried citrus pulp.

A larger percentage of dried citrus pulp would have been used had the steers in Lot 3 shown an appetite for it. After 57 to 60 percent of the ear corn chop with husk had been replaced with the dried citrus pulp the appetites of the steers in Lot 3 began to decline. A dry roughage supplement was not included in the rations in this trial as was the case in 1937-38. The droppings were somewhat looser in Lot 3 than in Lots 1 and 2, but there was no particular problem from scouring in Lot 3 at any time. A summary of the feeding trial is shown in Table 5.

**Table 5. Summary Second Feeding Trial November 16, 1938 to May 3, 1939—168 Days**

Lot number -----	1	2	3
Number of steers -----	10	10	10
Variables in feeding -----	Corn	25% citrus 75% corn	50% citrus 41% corn
Averages per Steer			
Initial weight, lbs. -----	555	556	555
Final weight at feedlot, lbs. -----	948	933	918
Final weight at San Antonio market, lbs. -----	904	895	869
Gain basis feedlot weight, lbs. -----	393	377	363
Gain basis market weight, lbs. -----	349	339	314
Daily gain basis feedlot weight, lbs. -----	2.34	2.24	2.16
Daily gain basis market weight, lbs. -----	2.08	2.02	1.87
Shinkage enroute market, percent -----	4.64	4.07	5.34
Slaughter data			
Carcass weight (hot), lbs. -----	568	579	553
Dressing % basis hot carcass and market weight -----	62.8	64.7	63.6
Dressing % basis hot carcass and feedlot weight -----	59.9	62.1	60.2
Carcass grades (Swift)			
11's choice -----	2	2	2
12's strictly good to choice -----	7	8	6
13's top medium to good -----	1		2
Feed consumed			
Ear corn chop with husk, lbs. -----	1983	1484	734
Dried citrus pulp, lbs. -----		495	1062
Cottonseed meal, lbs. -----	413	413	412
Hegari silage, lbs. -----	2489	2489	2479
Salt, lbs. -----	9.6	5.6	6.2
Pulverized oyster shell, lbs. -----	16.8	16.8	16.8
Average rations			
Ear corn chop with husk, lbs. -----	11.8	8.83	4.37
Dried citrus pulp, lbs. -----		2.95	6.32
Cottonseed meal, lbs. -----	2.46	2.46	2.45
Hegari silage, lbs. -----	14.82	14.81	14.76
Salt, ounces -----	.91	.53	.59
Pulverized oyster shell, lb. -----	.10	.10	.10
Feed consumed per cwt. gain basis feedlot weight			
Ear corn chop with husk, lbs. -----	505	394	202
Dried citrus pulp, lbs. -----		131	292
Cottonseed meal, lbs. -----	105	110	114
Hegari silage, lbs. -----	633	600	683
Cost of feed per cwt. gain (feed consumed)			
Basis feedlot weight -----	\$ 5.70	\$ 5.93	\$ 5.82
Basis market weight -----	6.42	6.60	6.73
Financial statement			
Initial cost at \$8.65 per cwt. -----	\$48.01	\$48.09	\$48.01
Feed cost (feed consumed) -----	22.41	22.36	21.14
Marketing cost at \$.33 per cwt. -----	2.98	2.95	2.87
Total cost (not including labor) -----	73.40	73.40	72.02
Amount received at \$10.25 per cwt. -----	92.66	91.74	89.07
Net return -----	19.26	18.34	17.05

On the basis of both feedlot and market weights, Lot 1 made slightly greater gain than Lot 2 in which the dried citrus pulp replaced 25 percent of the ear corn chop with husk. Lots 2 and 3 in which the dried citrus pulp replaced a portion of ear corn chop as in 1937-38 again made higher dressed yields than Lot 1, check group.

Financial return, with ear corn chop with husk and dried citrus pulp charged at the same price, favored Lot 1, check group, because of slightly greater weight at market.

The use of as much as 59 percent of dried citrus pulp as replacement for the ear corn chop with husk was less desirable than the use of only 25 percent. Lack of palatability resulting in decreased feed consumption, (Lot 3 consumed only 92 percent as much total concentrates as Lots 1 and 2), and slight laxative effect of the dried citrus pulp was apparently responsible for this result rather than a lack of productive energy in the feed. Based on a productive value of 72.2 therms per 100 pounds for the ear corn chop with husk and on feedlot gain, the average productive value for the dried citrus pulp fed to Lots 2 and 3 was 67.7 therms per 100 pounds.

In the 1937-38 trial it was noted that the lots fed dried citrus pulp in the ration had better appearance in regard to coat of hair. In this trial there were no appreciable differences in hair coat and all lots carried a desirable market finish.

### Results 1939-40

The thirty head of good quality Hereford steer calves used in 1939-40 were received October 30 but were not divided into groups and started on test until December 20. During this preliminary period of 51 days they made an average gain of 96 pounds per head and entered the test in good flesh.

As in the previous trials Lot 1 was fed ear corn chop with husk and Lot 2 was fed dried citrus pulp to replace 25 percent of the ear corn chop with husk. Lot 3 was fed the dried citrus pulp to replace 48 percent, 50 percent, 54.5 percent, 61 percent, 66.2 percent, and 67.6 percent of the ear corn chop with husk during the five successive 28-day feeding periods and the final 14-day period. An average of 59 percent of the dried citrus pulp and 41 percent of the ear corn chop with husk was fed during the 154-day feeding period.

Lot 1, fed the ear corn chop with husk had better appetite throughout the trial than Lots 2 and 3. Lot 3 was slow to take increase in concentrates after the third 28-day period and was irregular in appetite. Contrary to the procedure in the first trial the three lots were not held to the same level of concentrates but were fed according to appetite. As a result Lot 3 consumed only 90 percent as much concentrate feed as Lot 1; but Lot 2 consumed 99 percent as much as Lot 1. Apparently, the replacement of 25 percent of the ear corn chop with husk by dried citrus pulp had little effect upon feed consumption while the use of higher percentages as fed to Lot 3 reduced feed consumption.

There was some difficulty from looseness in the various lots from time to time. The condition occurred more frequently in Lot 3 than in the other lots which tends to confirm previous observations of a slight laxative effect of the dried citrus pulp. A summary of the feeding trial is shown in Table 6.

Table 6. Summary Third Feeding Trial December 20, 1939 to May 22, 1940—154 Days

Lot number -----	1	2	3
Number of steers-----	10	10	10
Variables in feeding-----	Corn	25% citrus 75% corn	50% citrus 41% corn
Averages per Steer			
Initial weight, lbs.-----	536	537	535
Final weight at feedlot, lbs.-----	873	861	827
Final weight at San Antonio market, lbs.-----	888	823	799
Gain basis feedlot weight, lbs.-----	337	324	292
Gain basis market weight, lbs.-----	302	286	264
Daily gain basis feedlot weight, lbs.-----	2.19	2.10	1.90
Daily gain basis market weight, lbs.-----	1.96	1.86	1.71
Shrinkage enroute market, percent-----	4.01	4.41	3.39
Slaughter data			
Carcass weight (hot), lbs.-----	522	518	502
Dressing % basis hot carcass and market weight-----	62.3	62.9	62.8
Dressing % basis hot carcass and feedlot weight-----	59.8	60.2	60.7
Carcass grades (Swift)			
11's choice-----	3	2	
12's strictly good to choice-----	6	8	8
13' top medium to good-----	1		1
14's medium-----			1
Feed consumed			
Ear corn chop with husk, lbs.-----	1902	1410	691
Dried citrus pulp, lbs.-----		469	990
Cottonseed meal, lbs.-----	376	376	373
Hegari silage, lbs.-----	1689	1671	1561
Salt, lbs.-----	6.25	7.05	8.85
Pulverized limestone, lbs.-----	14.1	14.1	14.1
Average rations			
Ear corn chop with husk, lbs.-----	12.35	9.16	4.49
Dried citrus pulp, lbs.-----		3.05	6.43
Cottonseed meal, lbs.-----	2.44	2.44	2.42
Hegari silage, lbs.-----	10.97	10.85	10.13
Salt, ounces-----	.66	.74	.74
Pulverized limestone, lb.-----	.09	.09	.09
Feed consumed per cwt. gain basis feedlot weight			
Ear corn chop with husk, lbs.-----	564	435	237
Dried citrus pulp, lbs.-----		145	339
Cottonseed meal, lbs.-----	112	116	128
Hegari silage, lbs.-----	501	516	535
Cost of feed per cwt. gain (feed consumed)			
Basis feedlot weight-----	\$ 9.51	\$ 9.80	\$ 9.99
Basis market weight-----	10.61	11.10	11.05
Financial statement			
Initial cost at \$8.26 per cwt.-----	\$44.27	\$44.36	\$44.19
Feed cost (feed consumed)-----	32.04	31.75	29.16
Marketing cost at \$.33 per cwt.-----	2.77	2.72	2.64
Total cost (not including labor)-----	79.08	78.83	75.99
Amount received at \$10.25 per cwt.-----	85.90	84.36	81.90
Net return-----	6.82	5.53	5.91

In comparing Lot 1, fed the ear corn with husk as the only carbohydrate concentrate, with Lot 3, fed an average of 59 percent dried citrus pulp, and 41 percent of the ear corn chop with husk, Lot 1 made 15 percent greater gain on basis of feedlot weights and had higher finish. Lot 2, receiving 25 percent of the dried citrus pulp as a replacement for the ear corn chop with husk made 11 percent greater gain than Lot 3 and had higher finish. Lot 1 made only 4 percent greater gain on basis of feedlot weights than Lot 2 in which dried citrus pulp replaced 25% of the ear corn chop with husk and this advantage almost disappeared on basis of the final carcass weights. Carcass grades were practically equal between these two lots. These results indicate that 25 percent of the allowance of the ear corn chop with husk in the fattening ration may be replaced satisfactorily by dried citrus pulp.

On the basis of financial return in this test it was more profitable to feed the ear corn chop with husk than to include dried citrus pulp in the ration when both feeds were charged at the same price. It was less profitable to feed the larger amount of the citrus pulp than the smaller amount. All of the lots sold at the same price; however, had Lot 3 been sold separately it would have brought a lower price than Lots 1 and 2 because of a lack of finish which was shown by carcass grades. Figures 2, 3, and 4 show the three lots of steers at the close of the feeding period. There was as in 1938-39 little if any difference in glossiness of coats of hair.

The average productive value of the dried citrus pulp fed to Lots 2 and 3 in this trial based on feedlot gain and a productive value of 72.2 therms per 100 pounds for the ear corn with husk was 68.4 therms.



Figure 2. Lot 1 (Check) at Close of 1939-40 trial. Fed Ear Corn, Chop With Husk, Cottonseed Meal, and Hegari Silage.





**Figure 3. Lot 2 at Close of 1939-40 trial. Dried Citrus Pulp Replaced 25 Percent of the Ear Corn Chop With Husk.**



**Figure 4. Lot 3 at Close of 1939-40 trial. Dried Citrus Pulp Replaced 59 Percent of the Ear Corn Chop With Husk.**

### Discussion

The experiments to determine the relative feeding values of dried citrus pulp and ear corn chop with husk were started in the fall of 1937 and continued through three feeding seasons.

A summary of each of the three tests, in which the average feed consumption, steer gains, and other pertinent data for each of the respective tests is included as shown in Tables 4, 5, and 6.

Lot 1, the check group, was fed the ear corn chop with husk as the carbohydrate concentrate, while in Lot 2, dried citrus pulp was included to replace 25 percent of the allowance of the ear corn chop with husk during the three feeding trials conducted in 1937-38, 1938-39, and 1939-40. Lot 3 was fed dried citrus pulp to replace an average of 45 percent of the allowance of the ear corn chop with husk in the first, and 59 percent in the second and third trials.

In the first trial with yearling steers, which extended over a 140-day period, Lots 1 and 2 were held to the same level of concentrate feed as was consumed by Lot 3, fed the larger amount of dried citrus pulp. In the two succeeding trials with steer calves, Lots 1 and 2 were not restricted to the same level of concentrates as were consumed by Lot 3, but were fed according to appetite and consumed approximately 8 to 10 percent more concentrate feed.

One-tenth ounce pulverized oyster-shell per head daily was fed in each of the three trials. Salt was available to the steers at all times.

In the first experiment, as shown in Table 4, an average of 3.2 pounds of cottonseed hulls was fed per head daily in addition to the silage, however, a dry roughage was not included in the last two trials.

Gains on basis of both feedlot and market weights favored the corn-fed group, Lot 1, over Lots 2 and 3 during the last two trials in which calves were used; but in the first trial with yearlings, Lots 2 and 3, in which the dried citrus pulp replaced a portion of the ear corn chop with husk, made greater gain than Lot 1. Lot 2, fed the smaller amount of dried citrus pulp, likewise made greater gain in each test than Lot 3, fed the larger amount of the dried citrus pulp.

Carcass grades, except for the first trial in which the ratings were only approximate, ranked in order of desirability were Lots 2, 1, 3. The differences were slight in each instance except for Lot 3 in the third trial, when this lot failed to attain desirable finish. In each of the three tests, Lots 2 and 3 in which dried citrus pulp replaced part of the corn made slightly higher dressed yields on the basis of both feedlot and market weights than Lot 1 fed entirely ear corn chop with husk as carbohydrate concentrate.

When dried citrus pulp was fed to replace 59 percent of the allowance of the ear corn chop with husk during the second and third trials, the ration was less palatable than when only 25 percent of this feed replaced the corn. Furthermore, gain and finish were reduced, and there was

also an indication of slight laxative effect during the second trial when the condition of the droppings was carefully observed.

The average productive value of the dried citrus pulp in therms per 100 pounds fed in these tests was 70.8 as compared with a calculated productive value of 71.5 therms for the corn chop with husk.

As shown in Tables 4 and 5, Lot 2, in which 25% of the ear corn chop with husk was replaced by dried citrus pulp, produced heavier carcasses than the check group which indicates an increased value of the limited amount of dried citrus pulp over a similar allowance of ear corn chop with husk. Then, if the final live weights of the respective lots are adjusted to a common dressing percentage each year to agree with the carcass weights, the gains calculated from the adjusted weights become more favorable to the lots fed dried citrus pulp. Lot 1, for example, had a weighted average of 340 pounds of feedlot gain for the three years, as compared with 333 pounds for Lot 2, and 315 pounds for Lot 3, fed the high percentage of dried citrus pulp, but on the adjusted basis, the respective average gains were Lot 1, 340 pounds; Lot 2, 351 pounds; and Lot 3, 327 pounds. While the differences in gain are not significant on this basis, the lots in order of desirability in gain rank 2, 1, 3, just as they do in average carcass weights, dressing percentage and carcass grade. Productive value of the dried citrus pulp, when based on the adjusted gains, feedlot basis, average 81.7 therms.

### Summary

1. Dried citrus pulp, when fed to replace not more than 25 percent of the ear corn chop with husk, resulted in the production of practically equal gains but slightly higher finish than groups fed ear corn chop with husk as the carbohydrate concentrate portion of the ration.
2. The replacement of as much as 60 percent of the daily allowance of ear corn chop with husk by dried citrus pulp produced a feed which was less palatable, and had slightly greater laxative effect, and reduced feed consumption, gains and finish.
3. In these tests a mixture of 75 parts ear corn chop with husk and 25 parts dried citrus pulp as the carbohydrate concentrate produced satisfactory results. Productive values in therms calculated from the actual feedlot gains were slightly lower for the dried citrus pulp than for the ear corn chop with husk; however, when gains were adjusted to agree with dressing percentage these values were higher for the citrus feed than for the ear corn chop with husk.
4. There were no distinguishing differences in the color of fat between the check groups fed ear corn chop with husk and those which received the dried citrus pulp as replacement of varying amounts of ear corn chop with husk.

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