BLACKSTRAP MOLASSES AS A PARTIAL SUBSTITUTE FOR CORN AND OATS FOR FATTENING STEER CALVES IN DRY LOT

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Bachelor of Science

University of Illinois

1930

Submitted to the Department of Animal Husbandry

Oklahoma Agricultural and Mechanical College

In Partial Fulfillment of the Requirements

For the Degree of

MASTER OF SCIENCE

1938

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PREFACE

The cattleman is constantly in search of knowledge that will enable him to produce beef at less unit cost and with the least possible risk. The unprecedented drouth of 1934 which continued through 1935 and 1936 gave him due reason to search far and wide for a substitute for corn that was not only high priced but extremely scarce; also this drouth damaged and imported corn was of uncertain feeding value. Furthermore, the relation of feed cost to finished beef price demanded cheaper cost of production.

Roughage, too, was a problem, but scarcity as well as freight rates made long shipments impossible, and limited the opportunity in cutting production costs to some concentrate feed that could be economically shipped from areas of production or even imported without excessive cost. The problem at hand was definitely one of concentrates.

Blackstrap molasses used previously as an appetizer, conditioner, and to increase the palatability of low grade roughages was selling at less than half the price of corn per pound. Hence it was considered in a new role, that of a substitute for part, if not all, of the corn in the ration. Many problems concerning its new use developed, and Mid-western Experiment Stations were flooded with inquiries regarding its best utilization. Therefore, during the 1934-37 period one-third of the agricultural experiment stations of the nation were conducting experiments using molasses with various combinations of grains and roughages.

The yearly importation of cane molasses from Cuba, Porto Rico,

and Hawaii is approximately 250 million gallons. The state of Louisiana produces annually approximately 12 million gallons which is used domestically.

The Oklahoma Agricultural Experiment Station conducted its first experiment using molasses in combination with corn and oats for fattening cattle in dry lot in 1937. The results obtained with the oat-molasses combination were so favorable that the experiment was repeated in 1938.

The author wishes to express his appreciation to Bruce R. Taylor, assistant professor of animal husbandry, for his efforts and guidance during the course of the experiment and the preparation of this thesis.

He also wishes to thank Dr. O. S. Willham and Mr. Allan D. Davis for their helpful suggestions and criticisms, and Dr. V. G. Heller of the Agricultural Chemistry Department for making the chemical analyses reported.

June, 1938 Ewell E. Green

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REVIEW OF LITERATURE

Gerlaugh (13), reports that the addition of one-half to one pound of cane molasses to a fattening ration of corn, corn silage, mixed hay, and protein supplement for steer calves increased both feed consumption and average daily gain.

Trowbridge (36), working with yearling steers found that 32 pounds of cane molasses replaced 17 pounds of shelled corn, 3 pounds of linseed meal, 56 pounds of corn silage, and 2 pounds of alfalfa hay in the production of 100 pounds gain. One pound of molasses was fed per steer per day.

Weber and Connell (38), report that cane molasses diluted with water and sprinkled over wheat straw or cottonseed hulls did not increase the amount of roughage consumed by yearling steers.

Jones et al (15), questions that any real benefit was derived from the feeding of 1.45 pounds of blackstrap molasses as an appetizer to steer calves being fattened in dry lot on a ration of ground milo heads, cottonseed meal, and sumac fodder.

McCampbell and Winchester (18), working with steer calves found that the addition of two pounds of cane molasses to a ration of shelled corn, cane silage, alfalfa hay, and cottonseed cake slightly increased the gains and improved the appearance of the calves, but increased the cost of gain and lowered the selling price twenty-five cents per hundred weight.

Sni-A-Bar Farms (30), report that the use of an alfalfa-cane molasses supplement with a ration of corn, cottonseed meal, and alfalfa hay in fattening fall calves produced average daily gains of 1.94 and 2.25

pounds per steer.

Gerlaugh (12), found that the addition of two pounds of cane molasses to the calf fattening ration of corn, protein supplement, silage, and mixed hay slightly increased both the rate of gain and selling price, but was not economical when molasses cost twenty percent more than corn per pound.

Templeton and Goodell (32), in a summary of four years work report the feeding of cane molasses with cottonseed meal to yearling steers and a few two-year-old steers, in amounts of three pounds or more, resulted in greater daily gains and produced slightly more finish by the end of the feeding period than the straight cottonseed meal ration. The steers made an average daily gain of 2.43 pounds per steer when fed 2.57 pounds of molasses per day with the cottonseed meal. The check lot gained an average of 2.28 pounds per steer per day.

Skinner and King (25), working with two-year-old steers found that the substitution of a small quantity of cane molasses for an equal quantity of corn in a ration of shelled corn, cottonseed meal, clover hay, and corn silage increased the appetites and the rate of gain of the steers. Each steer received 2.59 pounds of molasses daily.

Culbertson et al (6), report that cane molasses self-fed with shelled corn, linseed meal, and alfalfa hay to steer calves during the last ninety days of the feeding period did not increase the average daily gain over a check, or "no molasses", group. The steers that had access to the molasses self-feeder consumed 2.64 pounds molasses daily.

Barnett and Goodell (1), found cane molasses and cottonseed meal gave satisfactory results when fed as the only concentrates to yearling steers. The average amounts fed per steer per day were 2.95 and 5.21

pounds of molasses respectively.

Osland et al (22), using yearling steers report that the addition of approximately 3.75 pounds of beet molasses to a ration of barley, sunflower silage, and alfalfa hay increased the rate and lowered the cost of gains. In addition, the selling price and carcass grades were slightly increased. In this trial each ton of molasses fed replaced 881 pounds of barley, 2,546 pounds of sunflower silage, and 891 pounds of alfalfa.

Gerlaugh (11), found that self-feeding steer calves cane molasses with shelled corn, silage, protein supplement and mixed hay produced rapid gains and a high selling value. The calves consumed 4 pounds of cane molasses daily and made an average daily gain of 2.17 pounds per steer.

Snapp (26), reports that yearling steers fed a ration of one-half oats and one-half cane molasses made an average daily gain of 2.51 pounds per steer. In the same experiment a ration of molasses with no grain produced an average daily gain of 2.08 pounds per steer as compared to the check ration of corn which produced an average daily gain of 2.51 pounds per steer daily.

Shealy (24), reports that it is possible to use blackstrap molasses to replace twenty-five to forty percent of the shelled corn in a ration for fattening steers.

Missouri Experiment Station (19), reports that a ration of four parts cane molasses to one part cottonseed meal was ninety-two percent as efficient as a ration of ten parts corn to one part cottonseed meal when both rations were full-fed to yearling steers. (Differences in daily gains and in roughage consumption were not considered.)

Lantow (16), reports that approximately equal parts of cane molasses and cottonseed meal, as the sole concentrates for yearling steers, gave satisfactory results as to both rate and economy of gain.

Thalman (33), reports that cane molasses fed to yearling heifers up to fifteen pounds per head per day with silage, cottonseed cake, and ground limestone, had no detrimental effect upon the health of the animals. All lots fed molasses as a partial substitute for corn made satisfactory gains.

Weber (37), reports that cane molasses fed as a complete substitute for corn produced lower daily gains than the check lot, and 100 pounds of molasses produced only 17.2 pounds of gain when fed to calves, and 11.5 pounds of gain when fed to yearlings, while in the check lot 100 pounds of corn produced 21.6 pounds of gain.

Snell (28), working with yearling steers found that the addition of cane molasses to a dry ration of ground ear corn, cottonseed meal, and hay had no significant effect upon the digestibility of crude protein, ether extract, or crude fiber. However, the ash, calcium, and magnesium balances were increased in this ration of questionable mineral supply, whereas, the phosphorus balance was unchanged. The addition of silage to the dry ration had no significant effect upon the digestibility of the nutrients except to lower the digestibility of the ash. On the other hand, the addition of molasses to a silage ration lowered the digestibility of crude protein but increased the digestibility of the ether extract and ash.

From a monetary standpoint cane molasses fed in a dry ration had about ninety-four percent the value of ground ear corn, whereas, when fed in a ration with silage, molasses had only eighty-seven percent the

value of ground ear corn. Feed consumption was increased with the addition of molasses to either the dry ration or silage ration, showing that molasses stimulated the appetites of the yearling steers.

Briggs (4), in a digestion trial with lambs reports that the substitution of blackstrap molasses to the extent of one-half of the corn or oats in a corn-alfalfa or oats-alfalfa ration apparently did not alter the digestibility of crude fiber, ash, or nitrogen-free extract. However, the digestibility of crude protein and fat was lowered and, furthermore, the digestibility of fat in the corn-molasses combination was decreased more than in the oats-molasses ration.

Ferrin (10), working with swine found that a ration of ground oats and cane molasses was superior to a ration of ground shelled corn and cane molasses in the same proportions.

A summation of the results obtained from feeding cane molasses in various quantities and combinations in table form follows as table I. The listings are in the order of amounts fed.

Table I Results Obtained From Feeding Molasses in Various Quantities and Combinations

Station	Reference Number	Weight of Steers	Rate of Gain	Concentrates	Molasses per Day	Roughage	Number Days Fed
Ohio	(12)	394	1.78	Corn	.50	Silage and mixed hay	280
Iowa	(7)	900	2.88	Corn	1.00	Silage and clover hay	120
Texas	(15)	426	2.12	Ground milo heads	1.45	Sumac fodder	168
Louisiana	(28)	383	1.86	Corn	1.98	Grass hay	150
Iowa	(7)	900	3.19	Corn	3.00	Silage and clover hay	120
Georgia	(31)	533	2.50	Corn and velvet beans	4.20	Peanut hay	112
Nebraska*	(33)	506	2.24	Corn	5.36	Silage	134
Oklahoma	(3)	474	1.78	Corn	6.24	Prairie hay	162
Oklahoma	(3)	474	2.00	Oats	6.25	Prairie hay	162
Mississippi	(1)	806	2.40	Cottonseed meal	6.57	Silage	112
Oklahoma	(3)	474	1.72	Corn	8.42	Prairie hay	162
Missouri	(19)	648	1.80		10.89	Silage and alfalfa	133
Nebraska*	(33)	505	1.74		11.09	Silage	134
Illinois	(26)	750	2.08		13.36	Silage and alfalfa	150
Kansas	(37)	847	1.71		14.86	Silage and wheat straw	108

*Heifers

EXPERIMENTAL

Two Experiments Were Used in This Study

1937 - 1938

1937 Experiment

The object of this experiment was to study the relative value of blackstrap molasses as compared to corn and oats in fattening steer calves in dry lot.

Rations Used

Lot 1. Ground shelled corn, cottonseed cake, prairie hay, and ground limestone.

Lot 2. Ground shelled corn ($\frac{1}{2}$ of lot 1.), molasses (ad lib.), cottonseed cake, prairie hay, and ground limestone.

Lot 3. Ground shelled corn ($\frac{1}{4}$ of lot 1.), molasses (ad lib.), cottonseed cake, prairie hay, and ground limestone.

Lot 4. Ground oats (same as corn in lot 2.), molasses (ad lib.), cottonseed cake, prairie hay, and ground limestone.

1938 Experiment

The object of this experiment was to study the relative value of blackstrap molasses and oats as compared to corn for fattening steer calves in dry lot.

Rations Used

Lot 5. Ground shelled corn, cottonseed cake, silage, and ground

limestone.

Lot 6. Ground shelled corn (½ of lot 5.), ground oats (ad lib.), silage, and ground limestone.

Lot 7. Ground oats (½ the corn of lot 5.), molasses (ad lib.), silage, and ground limestone.

Calves Used

Thirty-two high grade Hereford steer calves from the E. C. Mullendore herd in Osage County, Oklahoma were used in the 1937 experiment.

Twenty-four head of Hereford steer calves of similar quality and grade and from the same herd were used in the 1938 experiment.

Method of Procedure

After fully recovering from the effects of weaning and shipping, the calves were identified by numbered leather neckstraps, weighed on three consecutive days, and divided into uniform lots of eight steers on the basis of average weight, quality, and indications of probable outcome. The steers were penned in identical paved feeding lots, thirty feet by thirty feet, with a sixteen foot shed on the north side. Wheat straw was used for bedding in the shed which had a dirt floor. Identical feed bunks and watering tanks were used in all lots.

The calves were hand-fed grain twice daily at 6:00 a. m. and 5:00 p. m. The lots receiving silage were fed silage after the grain was consumed, whereas, the lots receiving hay were fed hay at noon. All lots of steers had access to common salt and a mineral mixture of two

parts steamed bone meal, one part salt, and one part ground limestone. The molasses was diluted with water and poured over the grain in the 1937 experiment. In the 1938 experiment the molasses was warmed to facilitate pouring and mixing with the feed. The shelled corn and oats were necessarily ground when they were to be mixed with molasses, therefore, these feeds were ground for all lots. This was not done because experimental data indicated they should be ground for fattening young cattle, but to eliminate the possible effect of the preparation of the grains on the results of the experiment.

The grains were ground coarsely in a hammer mill; grinding about ten days' supply at one time. The molasses was purchased at Oklahoma City and stored in steel drums of fifty gallon capacity until used. The silage was made from drouth damaged atlas sorgo that contained practically no grain, however, it did have good color and palatability.

Both experiments were started in November and continued until April. The 1937 experiment covered 162 days, whereas, the 1938 experiment covered 154 days. Individual weights were taken every twenty-eight days. Two steers were removed from the test, one steer from lot 3 at the end of 72 days because of failure to gain, and the other from lot 7 at the end of 101 days due to actinomycosis.

The steers in the 1937 experiment were dehorned with a hot iron when they were small calves. However, ninety percent of the steers were re-dehorned during the pre-experimental feeding at the experimental barn. The steers in the 1938 experiment were dehorned with a saw on the sixteenth day of December.

Table II

Chemical Analysis of Feeds

Percentage of:	H_2O	Protein	Ash	Fat	Fiber	N. F. E.
Ground shelled corn (No.2)	12.79	10.11	1.41	3.89	1.98	69.82
Ground oats	10.75	13.88	3.36	3.30	10.42	58.29
Cottonseed cake (43%)	7.73	42.88	5.19	4.89	11.09	28.22
Prairie hay	9.19	5.63	8.87	2.13	30.50	43.68
Grain sorghum silage	71.50	2.64	2.45	.49	6.70	15.33
Molasses		Sugar		Ash		Solids
Average of all composite samples		48.32		8.47		69.86

The silage used had a carotene content of 4.8 parts per million.

Observations

1. The plan for the experiment called for the feeding of identical amounts of all feeds except those being tested.

2. The concentrate tested was allowed free choice, its value being checked against a one-fourth or one-half allowance of the check grain fed with it. This plan of feeding provided a check of the palatability of the different concentrates as well as their relative value as compared to corn.

3. The two lots of steers receiving molasses with corn in this experiment developed very dirty heads and throats by the eighty-fourth day of the test and this condition grew worse toward the end of the trial. During the latter weigh periods the neck strap and numbers would be so smeared with molasses that the metal numbers would have to be washed with water before individual identification could be made.

The two lots receiving similar amounts of molasses with oats as well as the "no molasses" lots remained clean about the head and neck at all times.

4. Lot 2 made unsatisfactory gains and required 763 pounds of concentrates and 227 pounds of hay to produce 100 pounds of gain. In this lot 350 pounds of molasses replaced only 144 pounds of corn and required an additional 14 pounds of cottonseed cake and 51 pounds of prairie hay to produce 100 pounds of gain.

5. Lot 3 was also unsatisfactory, making the lowest rate of gain of any lot and used the most feed to produce 100 pounds of gain. In this lot 489 pounds of molasses replaced 387 pounds of corn, but required 19 pounds of cottonseed cake and 69 pounds of prairie hay more than

the check lots required to produce 100 pounds of gain.

6. Lot 4 produced satisfactory gains from the standpoint of both rate and economy of gain.

7. The steers in lot 6 were well finished and made very satisfactory gains. In this lot 235 pounds of corn was replaced by 251 pounds of oats and 5 pounds of silage. The gains were identical with the check lot.

8. The steers in lot 7 were not quite as well finished as those of lots 5 and 6 but the gains were almost identical and the real differences were largely those of coat of hair, bloom, and trimness of middle.

9. The viscosity of the molasses had no apparent effect on palatability.

10. Several composite samples of molasses were analyzed and found to vary from 46.78 to 49.21 percent in sugar content. The ash content varied from 7.80 to 9.40 percent, whereas, the total solids varied from 68.28 to 72.96 percent. A gallon of molasses should weigh approximately 11.71 pounds.

11. The calves consumed from six to ten pounds of molasses per head daily and did not show any signs of tiring of the heavy allowance.

12. The check lot that received corn and the oats and molasses lot shrank almost identical amounts in marketing, but the corn lot averaged eight-tenths of one percent greater in dressing percent.

13. Lots 2 and 3 that received the ration of corn and molasses shrank more in marketing, but still dressed lower than the other lots of steers in the experiment.

14. In this experiment one lot of high quality, well bred calves

produced 100 pounds of gain on 572 pounds of concentrates and 550 pounds of silage.

15. The pens holding the groups fed molasses were noticeably wetter throughout the experiment than the other pens in the series.

16. The steers receiving molasses scoured more easily when handled than the check lot of steers. The lots receiving corn and molasses were noticeably worse in this respect than the lots receiving oats and molasses.

17. There were no dark cutters, yellow fat, or undesirable features of any of the carcasses produced in the 1937 experiment for which a carcass study is available.

Table III — Summary of 1937 - 1938 Experiments

Lot number	1	2	3	4	5	6	7
Number of steers per lot	8	8	7	8	8	8	7
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Initial weight per steer	476.00	473.00	473.00	473.00	466.00	467.00	470.00
Final weight per steer	810.00	762.00	752.00	797.00	767.00	768.00	765.00
Average daily gain per steer	2.06	1.78	1.72	2.00	1.95	1.95	1.92
Average daily ration:							
Ground shelled corn	11.44	5.54	2.90		9.15	4.57	
Ground oats				5.55		4.89	4.57
Molasses		6.24	8.42	6.25			5.74
Cottonseed cake	1.83	1.83	1.85	1.83	2.00	2.00	2.00
Prairie hay	3.65	4.05	4.23	4.04			
Silage					10.71	10.81	10.83
Ground limestone	.10	.10	.10	.10	.10	.10	.10
Nutritive ratio*	1:7.01	1:8.51	1:9.18	1:7.22	1:6.35	1:5.62	1:6.65
Total net energy*	11.76	10.71	9.91	9.93	10.44	10.01	9.37
Feed required per 100 lbs. gain:	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Ground shelled corn	555.40	311.04	168.48		469.23	234.36	
Ground oats				277.95		250.77	238.02
Molasses		349.85	489.36	313.36			298.96
Cottonseed cake	88.60	102.40	107.43	91.70	102.56	102.56	104.17
Prairie hay	176.97	227.06	245.65	202.34			
Silage					549.23	554.36	564.06
Dressing percent	58.40	57.60	57.00	57.30	59.50	62.20	59.00

*Calculated from (20)

Interpretations

Snedecor's (26) method of analysis of variance was applied to determine statistically the significance of the differences in rate of daily gain between the various lots of steers. The standard error of the mean difference between any two lots taken at random was found to be about 0.12 pound. In order to be significant the difference in rate of gain should be 2.13 times the standard error of the mean difference.

Applying these figures to the variations in gains from that of lot 1, lot 2 is shown to be barely significant, whereas, lot 3 is significant. Therefore, by this interpretation, the rations fed lots 2 and 3 were responsible for the differences in gains produced by these respective lots.

The percentage relationship of ground oats and blackstrap molasses to corn was calculated from the feed required to produce 100 pounds gain.

The plan of the experiment provided a test of the concentrate in question by using it (ad lib.) in place of one-half of the corn of the check lot or an identical amount of oats, the value of which was determined by direct replacement.

Considering the fact that the differences in gains were insignificant, or therefore, alike for calculations the relative value of molasses to corn was obtained as follows: The oats required for lot 7 was changed to its corn equivalent and a slight addition made for a cottonseed cake equivalent equal to the additional cottonseed cake

used in producing 100 pounds gain in this lot over that of lot 5.[1] This sum was then subtracted from the corn required to produce 100 pounds of gain in lot 5 and the remainder divided by the molasses required to produce 100 pounds gain in lot 7. This gave a relative value for blackstrap molasses of eighty-two percent that of ground shelled corn.

CONCLUSIONS

1. Blackstrap molasses and ground oats in equal proportions is a good substitute for ground shelled corn from the standpoint of rate and economy of gain. In these trials 100 pounds of blackstrap molasses was equal to 82 pounds of ground shelled corn.

2. The 1937 experiment indicates that replacing fifty to seventy-five percent of the ground shelled corn with blackstrap molasses is not satisfactory from the standpoint of rate of gain, economy of gain, appearance and bloom, or selling price.

3. On the basis of total pounds of concentrates consumed daily, it would appear that blackstrap molasses is equally as palatable as ground shelled corn when fed with either ground shelled corn or ground oats.

4. The viscosity of blackstrap molasses has no apparent effect on palatability but does affect ease of feeding in cold weather.

5. There is no indication that diluting blackstrap molasses with water is necessary for Oklahoma conditions.

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[1] Eighty-five pounds of cottonseed cake equals one hundred pounds of corn as found by Blizzard (3).

6. Blackstrap molasses gives approximately the same results when either silage or prairie hay is used as the sole roughage.

7. The daily consumption of molasses increased progressively with the weight of the calves.

8. These experiments emphasize the fact that economy of gain is more important than rate of gain in the economical production of choice light yearlings but that both are highly desirable.

9. Blackstrap molasses fed under the conditions of this experiment did not produce any objectionable features in the carcasses.

10. Blackstrap molasses has greater value when fed with corn or oats than the total digestible nutrients it contains would indicate for fattening steer calves.

11. Some regulation pertaining to the sugar content of molasses will be necessary before its use becomes wide spread as a reliable and satisfactory fattening concentrate.

BIBLIOGRAPHY

(1) Barnett, E. and Goodell, C. J.
1923. Preliminary reports of experiments with feeding steers using cottonseed meal and molasses. Miss. Agr. Exp. Sta. Cir. No. 48.

(2) Blizzard, W. L.
1937. Beef cattle feeding investigations. Okla. Agr. Exp. Sta. Prog. Rpt.

(3) ———————
1938. Beef cattle feeding investigations. Okla. Agr. Exp. Sta. Mim. Cir. No. 7.

(4) Briggs, H. M.
1937. The effect of molasses on the digestibility of a lamb fattening ration. Amer. Soc. An. Prod. 145-149.

(5) Brintnall, Earle
1921. Blackstrap molasses for dairy cattle. Miss. Agr. Exp. Sta. Cir. No. 38.

(6) Culbertson, C. C., Evvard, John M., Hammond, W. E., and Bassett, C. F.
1929. Cane molasses for finishing calves. Iowa Agr. Exp. Sta. Leaflet No. 27. An. Husb. Sec.

(7) Evvard, John M. and Culbertson, C. C.
1920. Cane versus beet molasses for fattening two year old steers. Iowa Agr. Exp. Sta. D-63. An. Husb. Sec.

(8) ——————— Culbertson, C. C., Sharp, L. B., and Burns, R. H.
1921. Cane versus beet molasses for fattening two year old steers II. Iowa Agr. Exp. Sta. D-70. An. Husb. Sec.

(9) Ferrin, E. F.
1936. Molasses as a substitute for grains. Minn. Agr. Exp. Sta. H-69. Div. An. Husb.

(10) ———————
1937. Cane molasses in hog rations. Minn. Agr. Exp. Sta. H-70. Div. An. Husb.

(11) Gerlaugh, Paul
1930. Molasses in rations for fattening calves. Ohio Agr. Exp. Sta. Bul. 463.

(12) ———————
1932. Molasses for fattening steer calves. Ohio Agr. Exp. Sta. The Bimonthly Bul. 154: 7-8.

(13) ----------
1932. Fattening steer calves. Ohio Agr. Exp. Sta. The Bimonthly Bul. 159: 215-217.

(14) ----------
1936. Fattening steer calves. Ohio Agr. Exp. Sta. The Bimonthly Bul. 179: 31-33.

(15) Jones, J. M., Keating, F. E., Jones, J. H., Black, W. H., and Howe, P. E.
1937. Full and limited feeding of fattening steer calves. Tex. Agr. Exp. Sta. Prog. Rpt. 461.

(16) Lantow, J. L.
1933. Steer fattening rations built largely around ground corn fodder and silage with cottonseed meal and molasses as the added concentrates. N. M. Agr. Exp. Sta. Bul. 211.

(17) McCampbell, C. W. and Winchester, H. B.
1921. Cattle feeding investigations, 1919-20. Kan. Agr. Exp. Sta. Cir. No. 86.

(18) ---------- and Winchester, H. B.
1921. Cattle feeding investigations, 1920-21. Kan. Agr. Exp. Sta. Cir. No. 92.

(19) Missouri Agricultural Experiment Station
1937. Blackstrap molasses in rations for fattening yearling steers. Mim. Rpt. Dept. An. Husb.

(20) Morrison, F. B.
1936. Feeds and feeding. 20th ed. unabridged. The Morrison Publishing Co., Ithaca, N. Y.

(21) Osland, H. B.
1933. Sugar-beet by-products for fattening livestock. Colo. Agr. Exp. Sta. Bul. 335-A.

(22) ---------- Maynard, E. J., and Morton, George E.
1936. Colorado fattening rations for cattle. Colo. Agr. Exp. Sta. Bul. 422: 28-31.

(23) Peters, W. H.
1933. Selection and purchase of feeders and rations for fattening beef cattle. Minn. Agr. Exp. Sta. Bul. 300.

(24) Shealy, A. L.
1933. Beef production in Florida. Fla. Agr. Exp. Sta. Bul. 260: 34.

(25) Skinner, J. H. and King, F. G.
1916. Winter feeding 1915-16. Ind. Agr. Exp. Sta. Bul. 191.

(26) Snapp, Roscoe R.
1937. Report on molasses feeding experiment. Tenth Annual Cattle Feeders' Meeting. Ill. Agr. Exp. Sta. Mim. Rpt.

(27) Snedecor, George W.
1934. Calculations and interpretations of analysis of variance and covariance. The Collegiate Press, Inc. Ames, Iowa.

(28) Snell, M. G.
1935. Blackstrap molasses and corn-soybean silage for fattening steers. La. Agr. Exp. Sta. Bul. 266.

(29) ---------- Upp, Charles W., and Lush, R. H.
1937. Blackstrap molasses as a livestock feed. La. Agr. Exp. Sta. Cir. No. 19.

(30) Sni-A-Bar Farms
1932-35. (incl.) Handling and feeding native fall calves. Sni-A-Bar Farms, U. S. D. A., and Mo. Agr. Exp. Sta. Coop. Rpts.

(31) Southwell, B. L.
1937. Steer feeding tests. Ga. Coastal Plain Exp. Sta. Prelim. Rpt.

(32) Templeton, George S. and Goodell, C. J.
1927. Steer feeding experiments and actuary. Miss. Agr. Exp. Sta. Bul. 242.

(33) Thalman, R. R.
1937. Molasses versus corn for fattening yearling heifers. Neb. Agr. Exp. Sta. Cir. No. 164.

(34) Thompson, C. P.
1937. Blackstrap molasses as a substitute for corn in fattening hogs. Okla. Agr. Exp. Sta. Mim. Rpt.

(35) ---------- and Hillier, J. C.
1938. Molasses for fattening hogs. Okla. Agr. Exp. Sta. Mim. Cir. No. 8.

(36) Trowbridge, E. A.
1924. The use of a limited amount of molasses in feeding yearling steers. Mo. Agr. Exp. Sta. Bul. 223.

(37) Weber, A. D.
1937. Molasses as a feed for beef cattle. Kan. Agr. Exp. Sta. Cir. 37-C.

(38) ---------- and Connell, W. E.
1935. Cattle feeding experiments 1934-35. Kan. Agr. Exp. Sta. Cir. No. 35.

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