BLACKSTRAP MOLASSES AS A PARTIAL SUBSTITUTE FOR CONCENTRATES IN FATTENING SWINE

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PREFACE

The man who is feeding hogs for the market is faced, even in normal years, with a feed problem, the solving of which may mean either a profit or a loss from this important farm enterprise. This problem is the securing of a concentrate that will produce gains cheap enough to allow the feeder a fair margin of profit.

This problem was intensified during the drought years of 1936-37, when corn and other grains were not only high in price but also low in quality and difficult to secure, and hog prices were below normal during this period.

Blackstrap molasses was selling for about one-half the price of corn per 100 pounds. A review of literature revealed that when fed in small amounts it could be satisfactorily substituted for grains in fattening swine. These trials indicated that it was easy to feed. In chemical composition it presented a fair picture. It contains no fiber, and does contain a large amount of sugars and is rather high in minerals. To determine whether a large amount of molasses could be used as a substitute for a portion of the corn and other grains in the ration, a series of experiments was planned by the Animal Husbandry Department of the Oklahoma Agricultural and Mechanical College.

The United States has an abundance of molasses at hand at all times. We import at present around 250 million gallons of molasses into this country every year from Cuba, Porto Rico and Hawaii, and the state of Louisiana produces annually about 12 million gallons.

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April, 1939 Alvin L. Neumann

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REVIEW OF LITERATURE

Smith (15) in a discussion of cane molasses, says:

> "Blackstrap is strictly a carbonaceous concentrate, sufficiently similar to corn in composition to suggest its use as a partial substitute for this grain in fattening rations. Due to its high water content, however, 100 pounds of molasses contains only about 70 percent as much digestible matter as an equal amount of corn. Its protein content is much lower and consequently its nutritive ratio much wider. The carbohydrate of corn is mostly starch and that of molasses is mostly sugar. Although sugar is more readily soluble than starch, the digestive system of the pig is apparently better adapted to the use of starch than of sugar."

Gantt (8) reports that while molasses is laxative in its effect, it makes a good addition to a ration if not used in too large quantities. For weanling pigs it should probably not be fed in amounts greater than 10 percent of the ration, while mature hogs can use as much as 25 percent with safety. As it contains no fiber, it fits in well with feeds with high fiber content, such as oats and barley, provided that the necessary protein supplements and green feeds are used.

Experiments at the Hawaii station have shown molasses to have a nutritive value about equal to barley when fed to fattening hogs in amounts up to 20 percent of the ration. These results are somewhat better than ordinarily would be expected, however, for molasses contains more water, and consequently about three-fourths of the total digestible nutrients of barley.

According to Fjeldsted and Potter (7) cane molasses can be used to good advantage in combination with other feeds. The tests at the Oregon station show that a lot of fifteen pigs receiving four parts mill run and one part molasses consumed as much mill run as similar lots receiving mill run alone. The gains were proportionally good, thus making cane molasses equal in efficiency with mill run and at the same time inducing greater consumption.

In another test conducted recently at Oregon, fifteen pigs having an average initial weight of 183 pounds consumed daily 10.7 pounds of a mixture of ground barley 72 percent, tankage 8 percent, and molasses 20 percent. They made a daily gain for sixty days of 2.11 pounds. In this test, molasses proved practically equal to ground barley pound for pound. They contend that molasses is clearly a valuable feed when it does not cost more than barley, wheat or corn. Molasses is used chiefly, however, by feed manufacturers in the preparation of mixed feeds.

Barnett and Goodell (1) conducted an experiment in 1919 when all feed prices were high, using rather large hogs, (initial weight averaged 161 pounds), seeking a substitute for the high-priced corn. In their test they fed corn, shorts and tankage as the basal ration and added molasses at the rate of 25 percent in one lot and 35 percent in another lot. The corn allowances were reduced in the same proportion that the

molasses was added. The final results show that the lot fed no molasses exceeded both molasses fed lots in economy of gain. The most expensive gains were made in the lot receiving 25 percent molasses. The rate of gain was about the same in all lots.

Molasses can quite often be obtained in the Pacific states for considerably lower prices per ton than the cereal grains, and for this reason the Washington station conducted a test to compare the feeding value of molasses to that of barley. As a result of this test, Hackedorn and Sotola (9) report that in dry-lot 91.10 pounds of barley were equivalent in feeding value to 17.11 pounds mill run plus .73 pounds tankage plus 227.79 pounds cane molasses. However, in another part of the test, where they fed the same ration of barley, mill run and tankage plus molasses in the same amount as barley, and let the pigs have access to pea forage, the molasses fed pigs required 34.67 pounds less concentrates per 100 pounds gain. In this part of the test 109.27 pounds barley, 10.88 pounds mill run, 4.18 pounds tankage, plus pea forage, was equal to 89.66 pounds of molasses plus pea forage.

Snell (17) conducted feeding trials with hogs at the Louisiana station, replacing corn in the ration at the rate of 5, 10, 15, 20, 25, 50, 75, and 100 percent. In none of these trials did molasses show any appreciable feeding value. Hence the Louisiana station does not recommend its feeding to hogs.

Henke (10), in a paper reviewing the work done with the feeding of molasses in Hawaii, includes the following composition tables:

Composition of Cane Molasses

	High Percent	Low Percent	Average Percent
Total solids	83.80	75.06	79.70
Sucrose	40.04	32.71	36.88
Glucose	21.55	6.04	13.99
Dextrose	11.05	3.00	6.76
Levulose	10.50	2.87	6.76
Ash (Sulphate)	14.49	8.36	10.15
Gums	12.63	4.89	8.79
Total Nitrogen	.996	.274	.563
Iron and Alumina	.443	.075	.214
Lime	2.34	.291	1.129
Magnesia	1.384	.270	.727
Potash	5.218	2.43	4.76
Soda	.428	.121	.228

Digestible Nutrients in Cane Molasses

	Percent
Dry Matter	74.3
Crude Protein	1.0
Carbohydrates	58.5
Fat	.0
Total Nutrients	59.5

Average Composition of Cane Molasses

	Percent
Moisture	25.7
Carbohydrates	65.0
Protein	3.2
Ether Extract (Fat)	.0
Ash	6.1

Mineral Constituents of Cane Molasses

	Percent
Potassium Oxide	50.83
Sodium Oxide	.78
Calcium Oxide	7.09
Iron Oxide	.32
Aluminum Oxide	.24
Silica	3.91
Phosphoric Acid	2.64

Morrison (12) reports that cane molasses contains on the average about 25.9 percent water and supplies only 56.6 pounds of total digestible nutrients per 100 pounds, which is only about 70 percent as much as is furnished by corn grain. Cane molasses weighs about 11.7 pounds per gallon, and therefore approximately 171 gallons make a ton.

The manufacture of one ton of cane sugar results, under average conditions, in the production of 450 pounds of blackstrap molasses.

Burns (3) reports that after a four-day preliminary feeding period, three lots of eight hogs were fed as follows:

Lot I - 40 pounds corn chops, 40 pounds molasses.

Lot II - 60 pounds corn chops, 20 pounds molasses.

Lot III - 80 pounds corn chops.

The first lot, receiving one-half molasses, made a gain of .9 pound daily and required 487 pounds corn and 466 pounds molasses per 100 pounds gain.

The second lot, receiving one-fourth molasses, made gains of 1.45 pounds daily and required 449 pounds corn and 145 pounds of molasses per 100 pounds gain.

The third lot, receiving all corn, gained 1.66 pounds daily on 522 pounds of corn per 100 pounds gain.

Wisconsin workers (2) experimenting with molasses as a substitute for corn for all classes of livestock, conclude that regular feeding of molasses, regardless of how it is fed, is not practical.

In the pig trials, molasses was fed in three different ways: (1) Mixed with the entire mixture, balanced according to the Morrison feeding standard, which mixture was fed out of self-feeders; (2) Mixed with the supplemental mixture, the corn being fed separately, but both feeds in self-feeders; (3) Mixed with the corn only, where both feeds, including the supplemental mixture, were self-fed separately. The object was to give molasses a chance to demonstrate its palatability and economy when fed in different ways; to obtain if possible,

information on the ability of the pigs to balance their own rations when grain and supplement are fed separately, as compared with the "free choice" method where the possibly greater palatability of one or the other parts of the ration might throw the ration out of balance in respect to protein. The rations in every case were balanced with the "Wisconsin mixture" made up of two parts tankage, one part linseed meal, and one part ground alfalfa hay, by weight.

The results indicated that where molasses replaced ten parts corn in the mixture, and where the ration of lot two is compared with the check ration, the pigs on the lot two molasses ration ate somewhat more feed and gained somewhat more rapidly, but in both experiments required more feed per 100 pounds gain, thus making their gains more expensive.

When the molasses in the ration of lot four was fed with the protein supplement, there resulted a somewhat higher protein consumption in both experiments and less economical gains. No significant advantage was noted from permitting pigs to balance their own rations.

In summary, the Wisconsin trials show that the molasses rations were palatable in every instance, but that there was no significant gain in weight or in milk production. Molasses was worth slightly more than corn in some cases, but in most cases was worth considerably less. Molasses was not worth its purchase price.

Robison (13) experienced difficulty in getting pigs fed shelled corn and supplement twice daily to take the desired

amount of a supplemental mixture containing 16 percent of cane molasses. The molasses averaged 2.5 percent of the total ration. The pigs receiving molasses made a much poorer relative showing than others on a similar ration containing no molasses.

Working with somewhat smaller pigs (50 pounds initial weight), Templeton and Green (18) fed two lots of twenty 50 pound pigs ninety-eight days. Results show that the pigs on the check ration of corn and tankage made an average daily gain of 1.49 pounds, as compared with 1.44 for those receiving a supplement of molasses hand fed twice daily at the rate of 0.5 percent of the live weight of the animals.

Ferrin (6), in speaking about the feeding value of molasses, states:

> "Molasses ranges from 20 to 25 percent moisture and contains an average of 62 percent carbohydrates. The digestibility of the carbohydrates is high, as they consist chiefly of sugars. There is an average of 2.8 percent of protein in cane molasses but the digestibility of the protein is less than 50 percent and hence molasses really only contains about 1 percent digestible protein. The mineral content is high as compared with grains, averaging about 10 percent. Cane molasses is more palatable than beet molasses and has been used to a considerable extent to increase consumption of coarse roughages fed to cattle and sheep."

Working at the Minnesota station, Ferrin (5) conducted a feeding trial during the fall of 1936 to test the substitution of cane molasses for grains in rations for fattening hogs. Pigs weighing 107 pounds per head at the start of the feeding period were fed in dry lot for an 81 day period. A combination of ground corn and molasses was compared with

50 percent ground corn, 50 percent ground oats, and molasses and also with ground oats and molasses. Tankage and a simple mineral mixture were fed to all lots.

A mixture of molasses and water was poured over the ground grain after it was placed in troughs. The pigs fed ground oats consumed more molasses than the pigs fed ground corn. Molasses made up 13.5 percent of the total ration for the corn fed pigs and 23.5 percent of all feeds for the lot fed ground oats. There was little difference in the average daily gains of the pigs fed oats and molasses compared with those fed corn and molasses. The oats-molasses combination produced 100 pounds of gain in weight at a feed cost of $8.78, while the cost for the corn-molasses lot was $10.62. Ground corn was valued at $1.00 per bushel and ground oats at $0.44 per bushel.

Another trial was conducted by Ferrin (6) but using lighter weight pigs. These pigs had an initial weight of 66 pounds and were fed for a period of 88 days. The same rations were used as in the trial just reviewed, with the exception that a protein supplement of two parts tankage, one part linseed meal, and one part alfalfa meal replaced the tankage. In all lots as much molasses was fed, after the pigs became accustomed to the feed, as they would eat without scouring. For the entire feeding period, lot one ate molasses to the extent of 20 percent of the total ration, lot two consumed 23 percent molasses, and lot three ate 24 percent molasses. The pigs in lot one showed a higher degree of finish

at the close of the experiment than those in the other lots, but there was no great difference in the degree of market finish among the three lots. There was a greater tendency for the corn-molasses lots to scour than the other oats-molasses lots.

Carroll (4) of the Illinois station recently conducted an experiment in which three lots of twenty pigs each were fed in open fallow lots from a beginning weight of 70 pounds to a finishing weight of about 200. The check lot received a mixed ration of corn, tankage, soybean oil meal, alfalfa meal, and salt. In the second lot enough molasses was substituted for corn to make it amount to 20 percent of the ration. Enough molasses was substituted for the corn in the third lot to make it 30 percent of the ration.

Lot I - Gained 1.79 pounds daily and required 392 pounds to produce 100 pounds of gain.

Lot II - Gained 1.44 pounds daily on the 20 percent molasses ration and required 476 pounds to produce 100 pounds gain.

Lot III - Gained 1.38 pounds daily on the 30 percent molasses ration and required 507 pounds to produce 100 pounds gain.

The pigs on the molasses rations were unthrifty as evidenced by their slower gains, lack of condition, rough coats of hair and loss of appetite. They required from twenty to twenty-seven days longer to attain finished weights.

Carroll suggests that the reason pigs do not do well on molasses is that the large quantities of sugar in the feed cause irritation in the stomach and result in excessive acid fermentation. Sherman (14) also suggests that the excessive sugars could cause the excess amount of acid suggested above.

Hunter (11) reports a trial using blackstrap molasses as a substitute for all or part of the corn in the ration for brood sows. The lots fed corn meal and molasses and those fed hominy feed and molasses did about as well as those on all corn. A lot not receiving any corn but a larger amount of molasses and with the right proportion of the other concentrates to the same nutritive ratio and the same amount of digestible nutrients, gained at a much slower rate, and showed a tendency to scour.

Weaver (20), as the result of a trial, feeding twenty-three pregnant sows a ration of six parts molasses, six parts wheat shorts and one part tankage, concludes molasses is a very unsatisfactory concentrate for sows. The sows produced undersize pigs and the amount of milk produced was inadequate.

Table I

Summary of Trials Reviewed

Station	Lot No.	Ref. No.	Initial Weight	No. Days Fed	Rate Gain	Basal Ration	Percent Molasses	Feed Per 100# Gain
Texas	I	4	116	91	.9	Corn Chops	50	953 lbs.
Texas	II	4	115	91	1.45	Corn chops	25	594
Oklahoma	I		78	89	1.39	Corn, shorts	20	482
Oklahoma	II		76	89	1.33	Shorts	40	491
Hawaii	I	11	70.5	70	1.16	Barley, protein	10	502
Hawaii	II	11	70.2	70	.92	Barley, protein	20	565
Miss.	I	1	161.5	51	.98	Corn, shorts, tankage	25	691
Miss.	II	1	160.8	51	1.08	Corn, shorts, tankage	35	665
Wash.	I	10	66	74	1.12	Barley, mill run, tankage	Same as Barley	596
Wash.	II	10	66	74	1.14	Barley, mill run, tankage	Same as Barley	250
Oklahoma	I		90	84	.74	Corn, tankage	25	556
Oklahoma	II		91	84	.52	Corn, tankage	50	886
Oklahoma	III		92	84	1.19	Oats, tankage	25	460
Oklahoma	IV		91	84	1.14	Oats, tankage	50	514
Illinois	I	5	70	73	1.44	Corn, protein supplement	20	476
Illinois	II	5	70	73	1.38	Corn, protein supplement	30	507

EXPERIMENTAL

Three Experiments Were Used in This Study

1937 - 1938

The objects of these experiments were as follows:

1. To determine the value of molasses when used to replace part or all of the corn in a ration of corn and shorts.

2. To determine the value of molasses when used to replace part of the corn or part of the oats in a ration of corn and tankage or oats and tankage, for fattening swine.

Method of Procedure

Forty head of purebred pigs with an average weight of 77 pounds were divided as evenly as possible into five lots of eight pigs each in the first trial. These pigs were of the Poland China, Duroc Jersey, Chester White, Berkshire and Hampshire breeds.

In the second trial forty-eight head of fall pigs, of the same type of breeding as those used in the first trial, were divided into six lots of eight pigs each. These pigs had an average initial weight of 91 pounds and were quite uniform in size.

Forty-eight pigs similar to the above breeding were selected from the college herd for the third trial. These pigs consisted mostly of gilts. The initial weights of these pigs were quite uniform and ranged from 83 to 130 pounds. They were divided into two classes in each lot with initial weight

determining the class into which they would fall. All pigs with an initial weight of 100 pounds and above were placed in one class and all those under 100 pounds in another class. Thus four heavier and four lighter pigs were placed in each lot at the beginning of the trial. This was done to follow up the observation made in a previous trial that pigs with a higher initial weight made better gains on molasses rations than lighter weight pigs. However, the difference in initial weights of these pigs was really too small to cause any significant difference in final results.

These pigs were all housed in the same set of feeding sheds and lots. The feeding lots were of uniform size and had concrete floors. The sheds were also of equal size and they opened to the south. The sheds likewise had concrete floors. Consequently the pigs were entirely on concrete floors during the experiments. The feeders, water containers and other equipment were as nearly alike as possible.

The pigs were fed three times daily and had access to fresh water and minerals at all times. The mineral mixture was made up of equal parts of ground limestone, steamed bone meal and salt. The rations were all hand full-fed in a moist state, the molasses being mixed with the balance of the ration immediately before feeding.

The yellow corn used in these trials was coarsely ground and the oats were ground finely. Regular digester tankage, containing 60 percent crude protein, was used in those rations

containing tankage. The cane molasses used contained 53.89 percent invert sugar and 8.85 percent ash.

All the pigs were weighed at regular 10 day intervals. They were oiled when necessary to control lice. Since these trials were all conducted during the warmer months, it was not necessary to warm the molasses. The pigs in the first trial were fed 89 days, those in the second 84 days, and those in the third 91 days.

Experimental Results

Experiment I

January 15, 1937 to April 14, 1937

The object of this trial was to determine the relative value of cane molasses when used to replace part or all of the corn in a ration of corn and shorts for fattening swine.

Rations Used

Lot I - Equal parts (by weight) of yellow corn and wheat shorts, plus the mineral mixture.

Lot II - 25 parts yellow corn, 55 parts wheat shorts, and 20 parts cane molasses, plus the mineral mixture.

Lot III - 40 parts molasses and 60 parts shorts, plus the mineral mixture.

Summary of Results

The pigs on the rations containing molasses scoured badly at first but this did not seem to handicap them after

the first few days. The pigs consumed the molasses readily from the start, indicating the molasses was palatable.

The most rapid gains were made by lot two, as is shown in Table II. Only about half of the corn was replaced by molasses in this lot. The cost per 100 pounds gain was 76 cents higher in this lot, however, than in the other molasses lot, due to the rather high price of corn.

The smallest amount of feed for 100 pounds gain, 463 pounds per 100 pounds gain, was required in the check lot or lot one. The cost, which was $9.28 per 100 pounds gain, was higher than either of the two molasses lots. The other two lots cost $8.67 and $7.91 per 100 pounds gain, respectively.

There was no significant difference, as far as gains were concerned, between lot two, in which only part of the corn was replaced by molasses, and lot three, in which all the corn was replaced by molasses. There was also no significant difference in the efficiency of gains in these two lots.

In this trial molasses cost about 54 percent as much as corn and was actually worth about 84 percent as much as corn, based upon the gains made.

Experiment II

January 24, 1938 to April 18, 1938

The object of this experiment was to determine the value of cane molasses when used to replace a part of the corn or a part of the oats in a ration of corn and tankage or of oats and tankage, for fattening swine.

Table II

Results of the First Trial

(January 15, 1937 to April 14, 1937)

Lot Number	I	II	III
Ration:	Corn 50# Shorts 50# Mineral Mixture	Corn 25# Shorts 50# Molasses 20# Mineral Mixture	Shorts 60# Molasses 40# Mineral Mixture
Pigs Per Lot(1)	8	8	8
Average Initial Weight	77	78	76
Average Final Weight	189	202	193
Average Total Gain	112	124	117
Average Daily Gain	1.32	1.39	1.33
Average Feed Consumed Daily per Pig	6.12	6.70	6.53
Salt or Mineral Consumed during Experiment	44	34	44
Feed Required for 100# Gain:			
Corn	232	122	-
Wheat Shorts	231	262	295
Molasses	-	98	196
Total Feed Required for 100# Gain:	463	482	491
Cost of Feed per 100# Gain:	$9.28	$8.67	$7.91

(1)As pigs in the various lots reached 225 pounds they were weighed and removed from the trial.

Price of Feeds

Corn	$2.05	per cwt.
Shorts	1.95	" "
Molasses	1.10	" "

Rations Used

Lot I - Received a ration made up of 89 pounds of ground shelled corn and 11.0 pounds of tankage, plus the mineral self-fed.

Lot II - Received a ration made up of 63 pounds of ground shelled corn, 25 pounds of cane molasses, and 12 pounds of tankage, plus mineral self-fed.

Lot III - Received a ration made up of 38 pounds of ground shelled corn, 50 pounds of cane molasses, and 12 pounds of digester tankage, plus mineral self-fed.

Lot IV - Received a ration consisting of 96.7 pounds of ground oats and 3.3 pounds of tankage, plus mineral self-fed.

Lot V - Received a ration made up of 68 pounds of ground oats, 25 pounds of molasses, 7.0 pounds of tankage, plus mineral self-fed.

Lot VI - Received a ration consisting of 41 pounds ground oats, 50 pounds molasses and 9.0 pounds tankage, plus mineral self-fed.

Summary of Results

None of the pigs scoured badly at any time during the trial. In the first trial considerable scouring was noted.

The most rapid and most economical gains were made in lot four. The pigs in this lot received a ration of oats and tankage and no molasses.

All of the lots receiving oats made more rapid and more economical gains than those receiving corn.

Table III

Results of 84-Day Feeding Trial
(January 24, 1938 to April 18, 1938)

Lot Number	I	II	III	IV	V	VI
Rations:	Y. Corn 89# Tankage 11#	Y. Corn 63# Molasses 25# Tankage 12#	Y. Corn 38# Molasses 50# Tankage 12#	Oats 96.7# Tankage 3.3#	Oats 68# Molasses 25# Tankage 7#	Oats 41# Mol. 50# Tank. 9#
Pigs Per Lot	8	8	8	8	8	8
Average Initial Weight	91	90	91	91	92	91
Average Final Weight	165	153	135	191	193	187
Average Total Gain	74	63	44	100	101	96
Average Daily Gain	.88	.74	.52	1.18	1.19	1.14
Average Daily Feed Consumed Per Pig	4.33	4.22	4.52	4.67	5.51	5.87
Feed Required Per 100 lbs. Gain:						
Corn	438	382	442			
Oats				383	332	280
Molasses		113	287		92	170
Tankage	55	71	137	13	36	64
Total Feed Per 100 lbs. Gain	493	556	866	396	460	514
T. D. N. Per 100 lbs. Gain	395.9	427.2	625.4	283.9	307.4	346.3
Cost Per 100 lbs. Gain	$5.72	$6.57	$10.19	$3.46	$4.40	$5.27

Price of Feeds:

Corn.....$1.07 per cwt.
Oats..... .84 " "
Molasses..... 1.00 " "
Tankage..... 1.90 " "

The pigs in lot four, or those on oats and tankage, required only 396 pounds per 100 pounds gain, the smallest amount of feed per 100 pounds of gain. Undoubtedly the high water content in the rations fed to lots two, three, five and six contributed to the high feed requirements per 100 pounds gain in these lots. These lots were the ones that received molasses in their rations.

In lot two the molasses made up 25 percent of the ration. In this lot 100 pounds of molasses and an additional 15 pounds of tankage were required to replace 49 pounds of corn in producing 100 pounds of gain.

In lot three molasses made up 50 percent of the ration. Here 100 pounds of molasses and an additional 24 pounds of tankage were required to produce 100 pounds gain. In other words, the substituting of molasses saved practically no corn and required 24 pounds of tankage in addition.

In lot five molasses made up 25 percent of the ration. In this lot 100 pounds molasses and an additional 25 pounds of tankage were required to replace 55 pounds of oats in producing 100 pounds of gain.

In lot six molasses made up 50 percent of the ration. In this lot 100 pounds of molasses and an additional 30 pounds of tankage were required to replace 61 pounds of oats in producing 100 pounds gain.

In lot three 625.4 pounds of total digestible nutrients were required to produce 100 pounds gain, in which lot half

of the ration was made up of molasses. The other half of the ration was made up of 38 percent corn and 12 percent molasses.

In lot four, 283.9 pounds of total digestible nutrients were required to produce 100 pounds of gain.

The amount of total digestible nutrients required to produce 100 pounds gain increased in both the corn and oats lots as the molasses was increased. A much greater increase was noted in the corn lots.

The smallest amount of total digestible nutrients required in the corn lots per 100 pounds gain was greater than the largest amount required in the oats lots.

In this trial the high water content of the molasses does not seem to account for the increase in total digestible nutrients required per 100 pounds gain as the proportion of molasses in the ration increases.

Experiment III

July 15, 1938 to October 14, 1938

The object of this trial was like the one just discussed, with one exception. Alfalfa hay was added to all the rations.

Rations Used

Lot I - Received a ration made up of 90 pounds ground oats, 5 pounds tankage, and 5 pounds of ground alfalfa hay, plus mineral self-fed.

Lot II - Received a ration made up of 65.25 pounds ground oats, 21.75 pounds of cane molasses, 8 pounds of tankage, and 5 pounds of ground alfalfa hay, plus mineral self-fed.

Lot III - Received a ration made up of 42.5 pounds of ground oats, 42.5 pounds of cane molasses, 10 pounds of tankage, and 5 pounds alfalfa hay, plus mineral self-fed.

Lot IV - Received a ration consisting of 83 pounds of ground shelled corn, 12 pounds of tankage, and 5 pounds of ground alfalfa hay, plus mineral self-fed.

Lot V - Received a ration of 61.5 pounds ground shelled corn, 20.5 pounds of cane molasses, 13 pounds of tankage, and 5 pounds of ground alfalfa hay plus mineral self-fed.

Lot VI - Received a ration consisting of 40.5 pounds of ground shelled corn, 40.5 pounds of cane molasses, 14 pounds of tankage, and 5 pounds of ground alfalfa hay plus mineral self-fed.

The varying amounts of tankage were fed in order to give all the rations approximately the same nutritive ration, namely, one to five. It will be noted that in every case the tankage required to balance the ration increased as the amount of molasses increased, indicating its low protein content.

Summary of Results

The variation in the average daily gains per pig was analyzed according to Snedecor (16). The analysis showed a small variation within lot and a highly significant difference between lots. This indicates that there was a significant difference in daily gains between lots, and since the rations used was the only factor that varied from lot to lot, these differences must be the results of differences in rations.

Table V
Results of 91-Day Feeding Trial
(July 15, 1938 to October 14, 1938)

Lot Number	I	II	III	IV	V	VI
Rations:	Oats 90# ---- Alfalfa 5# Tankage 5#	Oats 65.25# Mol. 21.75# Alfalfa 5# Tankage 8#	Oats 42.5# Mol. 42.5# Alfalfa 5# Tankage 10#	Corn 83# ---- Alfalfa 5# Tankage 12#	Corn 61.5# Mol. 20.5# Alfalfa 5# Tankage 13#	Corn 40.5# Mol. 40.5# Alfalfa 5# Tankage 14#
Pigs Per Lot	8	8	7	8	8	8
Average Initial Weight	101	104	104	100	100	102
Average Final Weight	177	184	197	226	212	195
Average Total Gain	76	80	93	126	112	195
Average Daily Gain	.84	.87	1.01	1.38	1.23	1.02
Average Daily Feed Consumed Per Pig	4.55	4.96	6.17	5.13	5.11	5.80
Feed Required Per 100 lbs. Gain:						
Oats	489.0	375.6	257.1			
Corn				307.5	255.7	230.3
Molasses		118.0	257.2		87.7	231.3
Tankage	27.2	45.4	60.5	44.5	54.4	79.8
Alfalfa	27.2	28.4	30.2	18.5	20.9	28.5
Mineral	12.3	13.4	12.8	7.3	12.4	21.3
Total Feed Per 100 lbs. Gain:	555.7	570.8	617.8	377.8	431.1	591.4
T. D. N. Per 100 lbs. Gain:	344.4	376.0	391.8	291.8	307.9	393.2
Cost Per 100 lbs. Gain	4.50	5.22	6.02	4.14	4.78	6.63
Value of Molasses Per 100 lbs.		.41	.41		.29	-.07

Prices of Feeds Used:

Corn.....$ .56 per bu. Mineral.....$1.25 per cwt. Tankage.....$2.00 cwt.
Oats..... .24 " " Molasses..... 1.00 " " Alfalfa..... .50 "

Since the pigs were not fed individually, no study could be made of the variation in feed required per 100 pounds gain.

The pigs receiving corn and molasses scoured at various times during the experiment. The oats and molasses rations, however, did not scour the pigs.

It was observed that the pigs relished a mixture of oats and molasses more than a mixture of corn and molasses.

The pigs in lots four and five were ready for market at the end of the experiment, while those in the other lots needed considerably more finish. Lot four was the all corn plus supplement ration. Lot five had 25 percent of its corn substituted by molasses.

The average daily gains of the pigs fed oats and molasses increased with an increase of molasses, whereas the average daily gains of the pigs fed corn and molasses decreased with an increase of molasses.

In both cases the feed required per 100 pounds of gain increased with an increase of molasses. This is no doubt due to the high water content of the molasses (23.4 percent). The total digestible nutrients required per 100 pounds of gain would present a more desirable picture.

The most rapid and most economical gains were made in lot four, or in the all corn lot. The pigs in this lot made an average daily gain of 1.38 pounds per pig and produced 100 pounds of gain on 307.5 pounds of corn plus 44.5 pounds of tankage and 18.5 pounds of alfalfa hay. The cost was $4.14 per 100 pounds gain.

In lot two 118 pounds of molasses and an additional 18.2 pounds of tankage and 1.2 pounds of alfalfa hay were required to replace 113.4 pounds of oats in producing 100 pounds of gain, and the cost was $5.22 per 100 pounds gain.

In lot three 257.2 pounds of molasses plus 33.3 pounds of tankage and 3 pounds of alfalfa replaced 231.9 pounds of oats in producing 100 pounds of gain. The cost per 100 pounds gain was $6.02.

The pigs in lot five required 87.7 pounds of molasses plus 9.9 pounds of tankage and 2.4 pounds of alfalfa hay to replace 51.8 pounds of corn in producing 100 pounds of gain. The gains in this lot cost $4.78 per 100 pounds.

The pigs in lot six required 231.5 pounds of molasses plus 35.3 pounds of tankage and 10 pounds of alfalfa hay to replace 77.2 pounds of corn in producing 100 pounds of gain. Cost for 100 pounds of gain in this lot was $6.63.

Considering gains only and figuring the feeds concerned at the prices in Table V, molasses proved to be worth $0.41 per hundred in lots two and three, $0.29 per hundred in lot five, and less than nothing in lot six.

On the basis of total digestible nutrients required per 100 pounds of gain, lot four excelled all other lots, 291.84 pounds of total digestible nutrients being required per 100 pounds gain.

The largest amount of total digestible nutrients was required by the pigs in lot six, which required 393.19 pounds of total digestible nutrients per 100 pounds of gain. This was the half corn half molasses plus supplement lot.

Table IV

Chemical Analysis of Feeds

Percentage Of:	H_2O	Protein	Ash	Fat	Fiber	N. F. E.
Ground Shelled Corn	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

Molasses	Sugar	Ash	Solids
Average of All Samples:	48.32	8.47	69.86

In both the oats and corn lots the total digestible nutrients required per 100 pounds gain increased as the amount of molasses was increased.

DISCUSSION

Considerable scouring was noted in all the lots in the first trial. The wheat shorts apparently did not make too satisfactory a combination with molasses. All of the pigs which were on rations containing oats did not scour at any time during the trials. When corn and molasses were combined in a ration, scouring took place. It appears that the fiber content brought about this difference. The fibers possibly help spread the sugars throughout the stomach and thus slow down fermentations and the production of gases. This is in agreement with the suggestions of Carroll (4) and Smith (15).

Molasses was shown to be palatable and relished by swine. All of the pigs in lots receiving molasses rations consumed more feed daily than those pigs on rations not containing molasses. Furthermore, as the pigs gained in weight, the daily consumption increased, which would indicate that they do not tire of the molasses. These results agree with other workers, including Fjelsted (7), Bohstedt (2), and Ferrin (5). Robison (13), on the other hand, had difficulties in getting the pigs to consume any appreciable amount of molasses.

The molasses used in these trials contained less sugars and more water, as shown in Table IV, than Morrison's composition tables indicate for average samples.

From the standpoint of rate of gain and economy of gain, cane molasses makes a good substitute for corn when in combination with shorts as indicated by the results in Table II.

There were no significant differences in gain between the pigs on shorts and corn and those on molasses and shorts. The gain of 1.33 pounds daily made by the pigs on the all molasses and shorts ration is a commendable one and is considerably higher than those obtained in the Mississippi trials (1).

In all three trials the daily gain decreased as the proportion of molasses in the ration was increased. The same was true of economy of gain. As the molasses in the ration was increased the total amount of feed required to produce 100 pounds of gain increased. Undoubtedly the high water content of molasses accounts for some of this reduced economy.

The work of Templeton (18) and Gantt (8) indicates that heavier weight pigs made better gains on molasses rations than lighter weight pigs. However, no significant differences in gains, made by heavier and lighter weight pigs, were experienced in these trials. There really was not enough difference in the initial weights of the pigs used in these trials to divide them into heavy and light classifications.

Alfalfa was added in the last trial primarily to increase the fiber content of the ration, but also to provide Vitamin A. The addition of the hay increased both the rate of gain and the economy of gain in the lots receiving corn and molasses. However, no such increases were noted in the oats and molasses lots. It appears that the oats supplies about the optimum amount of fiber and any further addition does not improve the ration. These results correspond with Hackedorn and Sotola (9), wherein they added pea pasture to

the ration and thereby nearly doubled the rate and economy of gain. It is possible the pea pasture furnished other desirable nutrients other than fiber and Vitamin A.

The feeding of molasses, at the rate of 25 percent or more in the ration, causes a very undesirable condition in the feed lots. The molasses lots were characterized by wet, dirty, sticky floors; rough, unthrifty appearing pigs, and an over abundance of flies. Much more labor was necessary to keep the feeding lots clean when molasses was fed in large quantities.

Molasses is easily fed in the summer or during the warm months. The author has not fed molasses in the winter, but some of the work reviewed indicated that some extra labor and equipment would be necessary since the molasses becomes very stiff and must be heated before it can be fed handily.

The poorest rate of gain made in these trials was .52 pound daily as indicated by Table III. This group of pigs received a ration of 50 pounds molasses, 38 pounds corn and 12 pounds tankage. These gains are lower than any found in reviewing the literature on the subject. In order to produce 100 pounds gain, 866 pounds of this ration were required. The best gains were made on a combination of 25 pounds corn, 50 pounds shorts and 20 pounds molasses. They gained at the rate of 1.39 pounds daily as indicated by Table II, and required 482 pounds of feed per 100 pounds gain.

In nearly all cases the pigs fed on molasses rations required additional feeding to get them ready for market after the close of the experiments. This was also the case in nearly all of the trials reviewed. The author is of the opinion that the pigs on the oats and molasses rations, although gaining more per day, were doing more growing and less fattening than those on corn and molasses. This was evidenced by the fact that they required an additional feeding period.

The author does not recommend the feeding of molasses in greater quantities than 25 percent and only then when other concentrates are high and molasses extremely cheap in price. It appears that the Wisconsin workers were quite correct when they stated the feeding of molasses supplies farm animals with a luxury not justified by the price one ordinarily has to pay for molasses.

SUMMARY

1. Molasses and oats make a better combination than a ration of corn and molasses.

2. It was observed that the pigs relished a mixture of oats and molasses more than a mixture of corn and molasses, indicating it is more palatable.

3. Pigs receiving a ration of corn and molasses scour more easily than pigs receiving oats and molasses.

4. From the standpoint of finishing hogs for the market, molasses does not equal corn. All the lots in the trial studied receiving molasses, excepting the one which received three-fourths corn and one-fourth molasses, required additional feeding after the trial to get them in condition to sell.

5. The consumption of molasses increased progressively with the increase in weight of the pigs, indicating the hogs did not tire of the ration.

6. The feed required per 100 pounds of gain increases as the amount of molasses in the ration increases. Part of this increase is no doubt due to the high water content of the molasses rations.

7. Corn, shorts and molasses make a desirable combination. The best and most economical gains were produced by this combination.

8. Molasses was not satisfactory as a substitute for either oats or corn from a standpoint of rate or economy of gain.

9. A 25 percent substitution of molasses for either oats or corn is more satisfactory than a 50 percent substitution.

10. The addition of alfalfa hay at the rate of 5 percent of the total ration to the corn-molasses ration helped materially in both the rate and economy of gain. This is no doubt due to the added fiber content supplied by the hay. Addition of hay to the oats ration did not bring about corresponding results. It seems that the oats alone supplies sufficient fiber and that the added fiber in the hay is more detrimental than beneficial.

11. Molasses fed in excess of 25 percent of the ration produced an undesirable environment in the feed lot.

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