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UTILIZING SWEET POTATOES AS FEED FOR DAIRY CATTLE

By

D. M. SEATH, L. L. RUSOFF,
G. D. MILLER AND CECIL BRANTON

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AND

AGRICULTURAL AND MECHANICAL COLLEGE
AGRICULTURAL EXPERIMENT STATION
W. G. TAGGART, *Director*

Summary

1. Sweet potatoes are a good carbohydrate feed for dairy animals when used freshly chopped or dehydrated. Sweet potato vines are also of value as a feed.

2. Sweet potato vines when used as a supplemental pasture for milking cows have shown increases in milk production averaging 19 per cent over that from cows on permanent pasture.

3. Freshly chopped sweet potatoes have been found to be 2.5 times as valuable as silage in the dairy ration.

4. In feeding experiments dehydrated sweet potatoes made from whole tubers were palatable, while a product of poor quality made from culled, bruised, and sectioned potatoes was slightly unpalatable.

5. For milk production, dehydrated sweet potatoes contained 88 per cent of the value of yellow corn meal, and they were approximately 17 per cent more valuable than ground ear corn, including cob and shuck.

6. Digestion trials showed that the good quality dehydrated sweet potatoes contained from 76 to 81 per cent total digestible nutrients, while a poor quality product contained 71 per cent T.D.N. on the dry basis.

7. The high carotene content of Porto Rico varieties of sweet potatoes increases the vitamin A value of the butterfat.

Utilizing Sweet Potatoes as Feed for Dairy Cattle

By

D. M. Seath, L. L. Rusoff, G. D. Miller and Cecil Branton*

There is much demand for information on the feeding value of sweet potatoes. Sweet potato tubers have been chopped and fed in the fresh stage, and the vines have been used as a supplemental grazing crop. Recently, dehydrated sweet potatoes, a product relatively new to most farmers, have appeared on the market.

Dairymen are especially interested in this dehydrated feed, which made its first appearance about 10 years ago but did not attain large-scale production until during World War II, when the demand for it as human food, especially for shipment abroad, caused a phenomenal expansion in the industry. At present there are 67 dehydrating plants in Louisiana, of which 50 are used exclusively for dehydrating sweet potatoes. Present evidence tends to indicate that a larger percentage of this dehydrated product will be utilized as livestock feed and that dairy herds will be fed a major portion of it. This will be especially true if the cost of the product is kept in line with its relative feeding value. Under such conditions this new product will do much toward helping southern communities produce more of their own concentrate feeds, thus reducing the heavy expense of importing these feeds.

I. Grazing Sweet Potato Vines

Not only is the sweet potato tuber an excellent cow feed, but the vine is likewise nutritious and is relished by dairy cows. Reports[1] made on experiments conducted for 7 years at the North Louisiana Experiment Station show the value of sweet potato vines as pasture (Table 1).

Stimulation to milk production was shown in all of the experimental trials by cows grazing sweet potato vines. This was especially true when cows had previously been grazing permanent pasture which was usually low in palatability and in production in the late summer and fall months. Over a 7-year period this average increase in milk yields for Jersey cows was 19 per cent. Likewise, the milk production averaged 10 per cent higher than when cows were grazing soybeans, thus giving evidence that sweet potato vines would rank near the top among supplemental crops available for stimulating higher milk yields during late summer and early fall months.

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* Dairy Husbandman, Associate Dairy Nutritionist, Assistant in Dairying, and Assistant Dairyman, respectively. Acknowledgement is made of the experimental work prior to 1939, particularly on utilizing the fresh sweet potatoes and vines, conducted by R. H. Lush, formerly dairy husbandman of the Station.

[1] Data taken from annual reports submitted to the Director by R. H. Lush, formerly dairy husbandman of the Louisiana Agricultural Experiment Station.

TABLE 1. Summary of Sweet Potato Vines Grazing Experiments at North Louisiana Experiment Station

Year of test	Acres sweet potatoes	Days grazed	Cow days per acre	Pounds milk per acre
1933	1.5	66	123	No record
1934	2.0	27	54	" "
1935	2.0	25	50	" "
1936	2.5	13	21*	" "
1937	2.0	25	85	1816
1938	2.5	48	87	2167
1939	2.5	30	36	851
Average	2.14	33.4	65.1	1611

*In 1936, 36 per cent of the vines were not consumed.

The period that the vines were grazed was relatively short, varying from 13 to 66 days and averaging 33.4 days. The cow days per acre were about double the number of grazing days and varied from 21 to 123 and averaged 65.1. This shows that the average carrying capacity was approximately 2 cows per acre for a period of 33 days.

Grazing of the sweet potato vines was started at varying times ranging from July 12 to September 19. Factors affecting the time when first grazed included time when potatoes were set out and the prevailing weather, particularly the amount and distribution of rainfall.

When sweet potato vines are grazed several times during the growing season instead of just before the tubers are harvested, there is an increase in the amount of grazing secured, but a reduction in the tubers harvested. This decrease in the yield of tubers averaged 21 per cent. There was a direct correlation between the time of grazing and the loss in yield of tubers. The earlier the vines were grazed, the greater the loss of potatoes harvested.

II. Feeding Freshly Chopped Potatoes

When sweet potatoes are chopped, as with a corn knife, and fed fresh they are relished by dairy cattle and are highly nutritious. When properly stored they can be thus fed over a period of 2 to 4 months and make an important contribution to the fall and early-winter ration at a time when milk-stimulating feeds are badly needed. In 4 feeding tests conducted at the North Louisiana Experiment Station[1] it was found that 100 pounds of chopped sweet potatoes equalled 250 pounds of sorgo or corn and soybean silage. Thus it would appear that dairymen in need of silage or without sufficient silage could feed 10 to 15 pounds

[1] Data taken from annual reports submitted to the Director by R. H. Lush, formerly dairy husbandman of the Louisiana Agricultural Experiment Station.

of chopped sweet potatoes daily per cow and could expect results comparable to the feeding of from 25 to 38 pounds of silage per cow daily.

III. Dehydrated Sweet Potatoes as Dairy Feed

Comparative Chemical Analyses

One of the first questions asked about the dehydrated sweet potato product is, how does its chemical analysis compare with that of the fresh sweet potato? In general, the answer most nearly correct is that the dehydrated product is the same as the fresh sweet potato after most of the water is removed. It takes about 3 pounds of the fresh potato to produce 1 pound of the dehydrated feed. The commercially dried product contains around 7 to 10 per cent water as compared to around 70 per cent for fresh sweet potatoes.

Shown in Table 2 are the chemical analyses* of the various dehydrated sweet potato products tested experimentally by the Dairy Research Department of the Louisiana Agricultural Experiment Station. Also are shown the average analyses of corn meal, ground corn with cob and shuck, and dried beet pulp. These are all similar in chemical analyses to dried sweet potatoes and are listed for comparative reasons only. Inspection of the percentages of these various constituents shows that the crude protein content of the dried sweet potatoes averages around one-

TABLE 2. Chemical Analyses of Dehydrated Sweet Potatoes Tested Experimentally Along with Other Feeds Similar in Feeding Value*

Kind of Feed	Year fed	Percentages of the various constituents					
		Water	Crude protein	Fat	Crude fiber	Nitrogen-free extract	Ash
Dehydrated sweet potatoes (starch variety)	1944	8.73	2.50	0.64	2.93	82.36	2.84
Sundried sweet potatoes (starch variety)	1944	16.80	4.13	0.85	3.48	70.56	4.18
Dehydrated sweet potatoes (Porto Rico)	1945	6.80	5.00	0.85	3.90	79.98	3.47
Dehydrated sweet potatoes (Porto Rico)	1946	7.04	4.69	1.24	1.55	82.39	3.09
Dehydrated sweet potatoes, poor quality, (Porto Rico)	1946	9.60	4.56	0.50	4.32	77.74	3.23
Corn meal (No. 1), listed for comparison	†	12.8	9.6	3.9	2.3	70.0	1.4
Corn, with cob and shuck, listed for comparison	†	9.0	8.7	3.2	10.4	66.8	1.9
Dried beet pulp, listed for comparison	†	18.0	9.0	0.8	18.8	59.9	3.5

*Frances Bonner and C. C. Moreland of the Feed and Fertilizer Laboratory aided with some of the analyses.

†Analyses of comparative feeds taken from F. B. Morrison's *Feeds and Feeding*. 12th Ed. 1945. The Morrison Publishing Co., Ithaca, New York.

half that found in the corn, corn with cob and shuck, and dried beet pulp. The fat content is very low compared to corn and about the same as for beet pulp. In crude fiber content, there is very little difference between the dried potato products and corn meal. On the other hand, the content of nitrogen-free extract (soluble carbohydrate) is slightly higher in dried sweet potatoes than in any of the comparative feeds listed.

Variations shown in the percentages of the various constituents in the dried sweet potato products is a point of special interest. This tends to suggest that factors such as the variety of potatoes, the fertility of the land on which the potatoes are grown, and the dehydrating process itself may all have important effects on the actual chemical analysis of the final product. In this connection, it should be pointed out that the Porto Rico varieties produce a dehydrated feed that is relatively high in its content of carotene, the yellow pigment converted by animals into vitamin A. At the other extreme is the white starch variety of sweet potato such as L 4-5, which produces a dehydrated feed containing little, if any, carotene.

Feeding Experiments

In the first feeding experiment, conducted in 1944, dehydrated sweet potatoes were compared with ground yellow corn meal. Air-dried sweet potatoes that were first chopped by a homemade shredder and spread over a concrete surface for drying were used for the first two periods of the trial. A shortage of this material necessitated using a commercially dried product for the last period of the experiment. Both products resulted from drying a high-starch sweet potato variety, such as the L4-5, developed by the Horticulture Research Department of the Louisiana Agricultural Experiment Station. During the war the portion of the acreage devoted to producing this starch variety decreased in favor of the sweeter Porto Rico varieties.

Simple concentrate mixtures were fed in this trial, for it has been shown that cows do not require a complex grain mixture.[2] The mixtures consisted of 3 parts by weight of ground dehydrated sweet potatoes, or 3 parts by weight of ground yellow corn; 1 part of 41 per cent cottonseed meal; and 1 per cent each of salt, special process steamed bone meal, and powdered oyster shell. These mixtures were fed to 16 Holstein and 4 Jersey cows at the rate of approximately 9 pounds for each pound of butterfat produced. In addition, each cow received approximately 30 pounds of corn silage and 17 pounds of either lespedeza or Alyce clover hay daily. For each period one-half of the cows received the sweet potato concentrate mixture and one-half received the corn concentrate mixture.

About one-half of the cows relished this starch variety sweet potato meal from the start. The other half required from one to four days to become accustomed to the change. After the change was completed, the cows ate sweet potato meal as readily as they ate corn meal. Changes in

[2] Louisiana Agricultural Experiment Station Annual Report, 1942-43, pp. 63-64.

body weights of the experimental cows gave no definite evidences that the two feeds differed significantly.

While the cows were fed the yellow corn meal mixture the daily milk yields averaged 27.4 pounds, as compared to 26.3 pounds while being fed the dehydrated sweet potato mixture. The difference of 1.1 pounds per cow daily represented 4.05 per cent. The butterfat yields also favored the corn meal mixture by an average of 4.55 per cent. Based on the replacement values of the two feeds in the dairy ration, this first trial indicated that dehydrated sweet potato meal was equal to approximately 88 per cent of corn.

A second feeding experiment was conducted in 1945. The commercially dried potatoes used in this experiment were the highly colored and sweeter Porto Rico variety. The product proved to be very palatable, and was readily eaten by all cows. The concentrate ration consisted of 3 parts, by weight, of dehydrated sweet potato meal and 1 part of cottonseed meal. To this was added 1 per cent each of salt, special process steamed bone meal, and oyster shell flour. The second concentrate ration was the same except that ground ear corn (including cob and shuck) replaced the sweet potato. Adjustment was made in the corn concentrate ration so that 20 per cent more corn, but the same amount of cottonseed meal, was fed as in the sweet potato ration. This was done in an effort to help compensate for the extra bulk in the form of cob and shuck found in the corn mixture.

Milk yields, based on a four per cent equivalent basis, were almost identical on the two rations, i.e., 24.9 pounds per cow daily on sweet potatoes, and 25.0 pounds on the corn mixture. Body weight changes of the 16 Holsteins and 4 Jerseys used in the experiment were almost identical. In general, they liked the sweet potato ration better than the more bulky corn ration which included the cob and shuck. This was a partial reflection of the chemical analyses of the two rations, which showed slightly less than one-half the fiber in the sweet potato mixtures as in the corn mixture. On the other hand, the corn ration contained slightly more protein.

This experiment indicated that 1.0 pound of sweet potato meal was approximately equal to 1.2 pounds of ground ear corn (including cob and shuck) when fed in combination with cottonseed meal to cows receiving legume hay and corn-soybean silage.

The high carotene content of the sweet potatoes increased the vitamin A content of the butterfat approximately 20 per cent over that of the butterfat produced from cows fed ground corn. The values were 43 international units per gram as compared to 35 international units per gram.*

The third experiment conducted at the Louisiana station, in 1946, demonstrated the importance of having a good quality product. One batch

* Miss Harvye Lewis of the Department of Agricultural Chemistry and Biochemistry determined the vitamin A assays of the butterfat.

of dehydrated sweet potatoes fed was that produced as a by-product from a commercial plant producing a food for human consumption. This poor quality dehydrated product resulted from utilizing cull potatoes, peelings, bruised sections of potatoes, etc., and was darker in color than the previous meals. However, this product appeared to be a desirable feed. Reactions of livestock told a different story. Many animals refused to eat normal quantities of the feed and would entirely go off feed from time to time. The same animals when fed dehydrated sweet potatoes made from whole tubers ate normal amounts each day.

IV. Digestion Trials*

Four dairy steers weighing from 400 to 500 pounds each were used as experimental animals. The procedure used included the use of at least a 10-day preliminary period and a 10-day collection period. The feces were collected in a canvas collection bag. A 1/50 aliquot was taken from each day's fecal output for each steer and stored in a refrigerator at O° C. until completion of the collection period. Nitrogen determinations were made on aliquots of the fresh excreta, while dried excretum samples were used for the other analyses.

The basal feeds used were common lespedeza hay, Alyce clover hay, or Kobe lespedeza hay and cottonseed meal. Digestion coefficients were determined for these feeds prior to each sweet potato digestion trial.

Trial I was made on a 1945 commercial dehydrated sweet potato meal (Porto Rico variety) using common lespedeza hay as a basal feed. Four to five pounds of dehydrated sweet potato meal were fed to each steer and replaced an equivalent amount of hay on the digestible protein and total digestible nutrients basis in the basal ration. The amount of hay was adjusted so that the animals maintained their weights during the preliminary period, after which the digestion trial was begun. Trial II made use of Alyce clover hay and a 1946 commercial dehydrated sweet potato meal; Trial III, Alyce clover hay and a 1946 commercial dehydrated poor quality sweet potato meal made from cull and sectioned potatoes; Trial IV, Kobe lespedeza hay and cottonseed meal and a 1947 commercial dehydrated sweet potato meal.

The compositions, average apparent coefficients of digestibility, and total digestible nutrients of the dehydrated sweet potatoes on the dry basis for the various trials are presented in Table 3.

The apparent variations and non-digestibility of the protein, fat and fiber of the dehydrated sweet potatoes as seen in Table 3 might be explained by the small proportion of the total intake of these constituents in the ration. The apparent non-digestibility of the crude protein may be due to several factors, namely, (a) heating of the protein during the drying process, which could tend to make it less digestible, (b) the

* L. L. Rusoff, D. M. Seath, and G. D. Miller. "Dehydrated Sweet Potatoes—Their Feeding Value and Digestibility." Jour. Dy. Sci. 10:1947 (in press).

presence of non-protein nitrogen compounds that are not digestible, or (c) an apparent depression of digestibility.

TABLE 3. The Composition, Average Apparent Digestion Coefficients, and Total Digestible Nutrients of Commercially Dehydrated Sweet Potatoes (Dry Basis)

Trial	Dehydrated sweet potatoes	Dry matter	Crude protein	Crude fat	Crude fiber	Nitrogen-free extract
		%	%	%	%	%
I	1945	92.70	5.39	0.91	4.21	86.28
II	1946	92.96	5.04	1.47	1.67	88.63
III	1946 (poor quality)	90.40	5.04	0.55	4.78	85.99
IV	1947	85.35	4.17	1.15	4.46	84.88

		Average Apparent Digestion Coefficients			Total digestible nutrients
				N.F.E.	
I	1945	16.71		94.46	81.06
II	1946	−24.74	49.07	84.53	76.38
III	1946 (poor quality)*	−52.36	.....	83.47	71.78
IV	1947	−40.29	94.17	88.23	79.31

*Analyses based on three steers only; product made from cull and sectioned potatoes was slightly unpalatable, one of the steers refusing to eat his quota.

In this study the coefficients of digestibility for the nitrogen-free extract were consistent. As this constituent made up over 84 per cent of the dry matter in the dehydrated sweet potato, the apparent lack of digestibility of the other constituents had but small effect on the total digestible nutrient content. The low content of protein precludes this product from being an important source of this nutrient. The total digestible nutrient values for commercial dehydrated sweet potatoes ranged from 76 to 81 per cent on the dry basis; the poor quality commercial dehydrated sweet potatoes made from cull potatoes, peelings, and bruised sections of potatoes contained 71 per cent total digestible nutrients.

V. Suggested Concentrate Mixtures Using Dehydrated Sweet Potatoes

Dairymen should keep in mind that simple concentrate mixtures when fed in combination with good pasture or other high quality roughage give results comparable to those secured by feeding complex concentrate mixtures.[2] The explanation, in view of present scientific knowledge, is that certain microorganisms such as bacteria live and multiply in the paunch of the cow and change some simple food nutrients into

[2] Louisiana Agricultural Experiment Station Annual Report, 1942-43, pp. 63-64.

more complex ones. For example, some of these microorganisms can convert simple proteins into more complex protein compounds. It is also known that certain vitamins (B family vitamins) are synthesized in the paunch of the cow. Therefore, simple concentrate mixtures when they are digested supply the necessary bodily requirements of dairy cattle. Simple-stomach animals such as the chicken and the hog, however, must have a complex ration because of their inability to synthesize sufficient quantities of these nutrients.

Experiments, as herein reported, made use of simple concentrate mixtures such as dehydrated sweet potato meal, cottonseed meal, and minerals. Such mixtures are listed below but, in addition, others are given in order to suggest many variations that can be used, depending on the amounts of various feed constituents available. It should be kept in mind that these other mixtures have not been tested experimentally at this station, but are based on the comparative value of dehydrated sweet potatoes as a replacement for corn and other similar feeds in the concentrate mixture. It should also be stated that it is necessary to use a dehydrated sweet potato product that has a naturally high palatability for best results.

I. To be fed with green succulent pasture or when cows are being fed liberal amounts of good legume hay.

1. (15% crude protein)
   500 lbs. sweet potato meal
   200 lbs. cottonseed meal
   10 lbs. salt
   7 lbs. bone meal

2. (15% crude protein)
   400 lbs. sweet potato meal
   200 lbs. bran
   200 lbs. cottonseed meal
   12 lbs. salt
   8 lbs. bone meal

3. (14% crude protein)
   200 lbs. sweet potato meal
   200 lbs. ground corn or hominy
   100 lbs. rice bran
   100 lbs. cottonseed meal
   9 lbs. salt
   6 lbs. bone meal

4. (14% crude protein)
   300 lbs. sweet potato meal
   100 lbs. cottonseed meal
   200 lbs. ground oats or wheat bran
   200 lbs. dried brewers' grain
   12 lbs. salt
   8 lbs. bone meal

II. To be fed with fair pasture or with mixed hay consisting of half legumes and half grasses.

5. (18% crude protein)
   300 lbs. sweet potato meal
   200 lbs. cottonseed meal
   7 lbs. salt
   5 lbs. bone meal
   5 lbs. oyster shell flour

6. (17% crude protein)
   300 lbs. sweet potato meal
   200 lbs. bran or ground oats
   200 lbs. cottonseed meal
   9 lbs. salt
   6 lbs. bone meal
   6 lbs. oyster shell flour

7. (17% crude protein)
   300 lbs. sweet potato meal
   100 lbs. dried citrus pulp
   100 lbs. dried brewers' grain
   200 lbs. cottonseed meal
   10 lbs. salt
   7 lbs. bone meal
   7 lbs. oyster shell flour

8. (16% crude protein)
   300 lbs. sweet potato meal
   200 lbs. rice bran
   100 lbs. rice polish
   200 lbs. cottonseed meal
   12 lbs. salt
   8 lbs. bone meal
   8 lbs. oyster shell flour

III. To be fed when pasture is very poor or when no legume hay is being fed.

9. (20% crude protein)
400 lbs. sweet potato meal
300 lbs. cottonseed meal
10 lbs. salt
7 lbs. bone meal
7 lbs. oyster shell flour

10. (20% crude protein)
200 lbs. sweet potato meal
100 lbs. ground ear corn with shuck
200 lbs. cottonseed meal
7 lbs. salt
5 lbs. bone meal
5 lbs. oyster shell flour

11. (20% crude protein)
100 lbs. sweet potato meal
100 lbs. molasses
300 lbs. dried brewers' grain
100 lbs. cottonseed meal
9 lbs. salt
6 lbs. bone meal
6 lbs. oyster shell flour

12. (20% crude protein)
200 lbs. sweet potato meal
100 lbs. dried citrus pulp
100 lbs. rice polish
300 lbs. cottonseed meal
10 lbs. salt
7 lbs. bone meal
7 lbs. oyster shell flour

The above rations are listed as suggestions to those wishing to use sweet potato meal in concentrate mixtures for dairy cows. Under the conditions listed each one should give satisfactory results, although there is no special ration that is particularly better than others. When the particular ingredients listed are not available at reasonable prices there are many substitutions that can be made. For example, soybean meal or peanut oil meal can substitute for cottonseed meal, rice polish or hominy for corn, beet pulp for dried citrus pulp, and wheat bran for ground oats. In the using of all the above rations it is best to feed the concentrate mixtures proportionate to the amounts of milk produced by each cow. As a general rule one should feed one pound of grain for each $2\frac{1}{2}$ to 4 pounds of milk produced, with Jerseys getting the narrower ratio and Holsteins the wider one and the other breeds intermediate.

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