

DRIED POTATO PULP FOR FATTENING CATTLE

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Several by-products resulting from processing agricultural products have been used successfully as feeds for livestock. Potato pulp, the residue remaining after water extraction of starch from the raw potato, has such a potential. A potato starch extraction plant at Grafton, North Dakota, currently is producing about 2,500 tons of dry potato pulp a year. The wet potato slurry residue as it comes from the extraction contains 85 to 87 per cent water. In this form, it is difficult to handle in a livestock feeding operation. Not only is handling expensive, but during cold weather the livestock have a tendency to eat less than desired of the wet product. Drying this pulp results in a "gritty-powder" material which can be stored in conventional storage, transported and mixed with other feeds.

Nicholson *et al.*, (1964) reporting research with a similar product in Nova Scotia, suggested that it was very difficult to pellet a ration containing 50 per cent or more potato pulp because the steam tended to form a paste with the starch in the pulp. No difficulty was encountered pelleting the rations in these North Dakota experiments where the per cent of potato pulp was 33 per cent or less of the mixture.

Dried potato pulp is lower in protein, higher in fiber (acid-detergent method) and higher in ash (minerals) than usual for the common feed grains. The acid-detergent fiber (ADF) values should not be confused with, or compared to the crude fiber estimated by the old "conventional" method. The ADF value is often higher (though not always) than the conventional crude fiber reported for a feed analysis because it is a more accurate measure of the total fiber content of a feedstuff. Table 1 pre-

sents average analysis of common feedstuffs from this area for comparison.

Table 1. Chemical Composition of Common Feedstuffs

Feed	Dry Matter %	Protein %	Fiber (ADF) %	Ash %	Phosphorus %
Alfalfa Pellets	90	16.0	32.4	9.8	0.20
Barley	88	13.1	7.3	3.3	0.38
Beet Pulp (Molasses)	90	9.8	24.6	9.8	0.20
Corn	82	9.2	3.3	1.5	0.26
Corn Roughage Pellet	96	6.5	36.3	6.9	0.15
Oats	89	12.9	14.0	3.6	0.41
Potato Pulp (dry)	90	7.8	17.5	6.0	0.13
Triticale	86	13.8	3.4	2.3	0.41

Nicholson *et al.*, (1964) reported on the feeding value of the potato pulp produced in the eastern provinces. In their experiment, substituting potato pulp for oats as 40 per cent of the concentrate mixture (about 30 per cent of total ration) resulted in an increase in gain and feed efficiency for fattening cattle. In this experiment, a small amount of molasses had been added to the potato pulp. In a second experiment, soybean oil meal was superior as a source of protein to urea alone or a combination of soybean oil meal and urea as a supplement to potato pulp.

At the Maine Experiment Station, Brugman and Dickey (1961) fed a potato pulp ration to fattening cattle with good results. However, the gains were greater when the potato pulp formed 35 per cent of the ration as compared to rations where the pulp accounted for 68 per cent of the ration. In another experiment, these workers reported that in digestion experiments with heifers, the TDN value of the potato pulp was 79 per cent. This potato pulp also had a small amount of added molasses. Nicholson and Friend (1965) measured digestibility of potato pulp and reported satisfactory digestibilities of the organic matter with sheep, horses and pigs. The digestion coefficient for the protein content of the pulp was rather poor, apparently due to an enzyme inhibitor in the pulp. This inhibitor was against chymotrypsin and trypsin.

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Friend *et al.*, (1963) fed a "molassed" potato pulp in rations to swine and reported that 15 per cent of the ration was probably the most feasible level to use in swine rations. Rosencrans *et al.*, (1968) reported satisfactory gains and feed efficiencies from inclusion of up to 20 per cent potato pulp in rations for growing pigs and calculated a TDN value of 73 per cent for the pulp from the data obtained. The method of extracting starch from the potato did not include enough heat to cook the residue, and so similar results could be expected for swine as when raw potatoes are fed.

It appears that this potato by-product varies somewhat due to area of potato production and the method of extracting the starch. Because of these variations, it was deemed necessary to evaluate the potato pulp in rations used in North Dakota.

Experimental Methods:

Experiment C-26. This experiment was designed to evaluate potato pulp as one-third of a high energy ration for fattening yearling cattle. Further, the experimental design allowed comparison of oats and barley as the basal grains in combination with potato pulp. Thirty-six thin yearling steers of mixed breeding, with Hereford color markings predominating, were purchased. After a few days on a conditioning feed and becoming accustomed to the new surroundings, they were allotted to a 2 x 3 factorial design (2 levels of potato pulp and 3 grain treatments) of six lots of six steers each.

Steers were individually weighed at 21-day intervals. The rations were fed inside, twice daily, in amounts the cattle would clean up by the next feeding. Prior to each weigh day, feed, but not water, was withheld for at least 12 hours. At the conclusion of the experiment, all steers were slaughtered by a local packer and carcass excellence measured.

The rations fed were completely mixed and pelleted without grinding the grains or regrinding the alfalfa or the beet pulp pellets. The resulting physical form was that of a mixture of pellets and crumbles with a minimum of "fines". The formulas for the supplement (WED-5) and rations are given in Tables 2 and 3.

Table 2. Supplement (WED-5), Experiment C-26

Ingredient	Per cent of Ration
Corn, yellow	15
Dicalcium phosphate	15
Limestone	10
Trace mineral salt	10
Wheat bran	48.3
Vitamin A premix, 5000 IU/gm - 300 gm)
Vitamin D premix, 15000 IU/gm - 10 gm	
Stilbestrol premix, 1 gm/lb - 500 gm	
Protein (by analysis)	13 per cent

In the original formulation, the potato pulp was included as 33 per cent of the ration. Urea was added at 1 or 2 per cent of the ration as a safety factor in insuring that lack of protein would not be a limiting factor. From subsequent analysis, it appears this precaution was unnecessary. In lots 3 and 6, the rations containing high levels of oats were fed for the first 63 days, the half-and-half

Table 3. Rations and Treatments for Experiment C-26

Lots (Rations)	1	2	3(a)	4	5	6(b)
Barley	84	—	42	50	—	25
Oats	—	84	42	—	50	25
Urea	1	1	1	2	2	2
Potato Pulp	—	—	—	33	33	33
Alfalfa Pellets	5	5	5	5	5	5
Beet Pulp	5	5	5	5	5	5
Supplement (WED-5)	5	5	5	5(c)	5(c)	5(c)
% Protein (Anal.)	12.7	14.5	11.7	13.7	14.3	14.7
% Phos. (Anal.)	0.48	0.40	0.40	0.39	0.42	0.41
% Fiber (ADF)	10.3	13.8	12.8	12.2	14.4	12.6

- (a) Ration 2 for first 63 days, ration 3 next 42 days, finish with ration 1.
 (b) Ration 5 for first 63 days, ration 6 for next 42 days, finish with ration 4.
 (c) Two pounds of pelleted corn roughage added per head to lots 4, 5 and 6 for last 85 days; see discussion.

mix of barley and oats was fed for the next 63 days, and the oats were eliminated and barley was fed for the remainder of the experiment. This treatment was included to see if oats would be of special value early in the fattening period. The analysis for protein, phosphorus, and acid-detergent fiber of these rations also is included.

Experiment C-28. To obtain more conclusive evidence on the feeding value of potato pulp, Experiment C-28 was designed as a 2 x 3 factorial to evaluate potato pulp at three levels with two levels of roughage. Thirty-six yearlings were purchased and handled in manner similar to that described for Experiment C-26. These cattle were of mixed breeding, including some of the three beef breeds and crosses of these breeds with dairy breeds. They were allotted, equalizing breeds as well as weight and condition within lots.

The formulas for the supplement (WED-6) and rations are presented in Tables 4 and 5.

Table 4. Supplement (WED-6), Experiment C-28

Ingredient	%
Dry Molasses	10
Linseed Meal	10
Dicalcium Phosphate	15
Limestone	10
Trace Mineral Salt	15
Wheat Bran	38
Vitamin A premix, 5000 IU/gm; 400 gm)
Vitamin D premix, 1500 IU/gm	
Stilbestrol, 1 gm/lb. 500 gm	
	2

Table 5 shows design of experiment as well as ration formulas used. Three levels of potato pulp (0, 15 and 25 per cent of ration) and two levels of

roughage (5 and 15 per cent of ration) were included as treatments. In Experiment C-26, including 5 per cent molasses beet pulp did not appear to give enough "roughage-effect" for the potato pulp fed lots. In this experiment, a corn roughage pellet was included at two levels. This corn roughage pellet was a by-product of corn syrup extraction from high-sugar corn. The roughage residue was put in

Table 5. Rations and Treatments for Experiment C-28

Lots (Rations)	1	2	3	4	5	6
Barley	84.5	69.0	58.75	74.0	58.75	48.5
Potato Pulp	0	15	25	0	15	25
Urea	0.5	1.0	1.25	1.0	1.25	1.5
Alfalfa Pellets	5	5	5	5	5	5
Corn Roughage Pellet	5	5	5	15	15	15
Supplement (WED-6)	5	5	5	5	5	5
% Protein (Anal) *		11.7	13.7	14.6	15.3	13.4
% Fiber (ADF) *		11.1	12.7	12.2	12.1	15.6

*Analysis of this ration inadvertently omitted.

piles where some "ensiling" went on prior to drying and pelleting. An average analysis of the product is given in Table 1. This pellet should have more "roughage value" than either beet pulp or alfalfa because of the higher fiber value. The rations were mixed in the manner described previously and pelleted with a minimum of grinding prior to pelleting. Again the physical form was as pellets and crumbles with a minimum of meal. However, pelleting the feed ingredients prior to grinding increased power needs and pellet die-wear.

Results and Discussion:

The pertinent results obtained from Experiment C-26 are summarized in Tables 6 and 7. The steers were on experiment for 168 days (December to May). The average daily gains for all steers was 2.19 pounds, with a standard deviation of 0.31 pounds. These gains were fair for cattle of this type. The average daily gain for the fastest gaining lot (lot 1) was 2.37 pounds and for the slowest gaining lot (lot 5) was 2.04 pounds, a difference of 0.33

Table 7. Summary of Results, C-26, by Treatments

Lots Treatment	1,2,3 No Pulp	4,5,6 Potato Pulp	1,4 Barley	2,5 Oats	3,6 Barley Oats
Average daily gain lb.	2.24	2.14	2.30	2.10	2.18
Feed/lb gain, lb.	8.43	8.97	8.48	8.85	8.76
TDN/lb gain, lb.	5.78	6.14	6.00	5.92	5.95
TDN c/m/lb, lb.	(1) 3.24	3.51	3.53	3.25	3.45

(1) TDN for gain only, maintenance requirements subtracted

pounds. However, because variation within lot was as large as difference between treatments, these differences were not statistically significant. Averaging the gains of the three lots on potato pulp (lots 4, 5, 6: Table 7) and comparing with the three without pulp (lots 1, 2, 3) shows that the potato pulp lots gained 95 per cent as fast as the controls. The data indicate that steers offered the control rations required 94 per cent as much feed per pound of gain as steers offered the potato pulp rations. Thus, it appears that 33 per cent (or 30%) of the ration was the upper limit for use of potato pulp in order to get the best results. In fact, the cattle receiving the 33 per cent level scoured and never seemed to get accustomed to this ration. After 70 days on feed, a pound of corn roughage pellets was added per head daily to the ration. This was increased to two pounds daily after the 85th day and continued for the remainder of the experiment. This seemed to help reduce the looseness of feces, and the cattle were easier to keep on feed. This addition had the effect of reducing the per cent of pulp in the ration to about 30 per cent, reducing the protein content by less than one percentage unit and increasing the fiber in the rations by about two percentage units.

Nicholson *et al.*, (1964) increased rate of gain of cattle being fattened by substituting potato pulp in place of oats in the rations for fattening cattle. Such was not the case in this experiment. The steers on the oats rations gained only 91 per cent as rapidly as those on the barley rations and required four per cent more feed per pound of gain. Sub-

Table 6. Summary Results, Experiment C-26 (6 steers per lot) Potato Pulp and Oats for Steers (168 days-yearlings)

Lot Number	1		2		3	4	5		6
	No Potato Pulp		No Potato Pulp				Potato Pulp		
Treatment	Barley	Oats	Barley-Oats	Barley	Oats	Barley-Oats	Barley	Oats	Barley-Oats
Initial weight lb.	687	698	700	695	674	695	695	674	695
Final weight lb.	1086	1058	1070	1067	1017	1057	1067	1017	1057
Average daily gain lb.	2.37	2.15	2.20	2.22	2.04	2.16	2.22	2.04	2.16
Feed/day, lb.	19.3	18.4	18.9	19.6	18.6	18.2	19.6	18.6	18.2
Feed/lb. gain, lb.	8.11	8.58	8.60	8.85	9.13	8.92	8.85	9.13	8.92
TDN/lb. gain, lb.	5.79	5.70	5.84	6.22	6.14	6.06	6.22	6.14	6.06
TDN c/m/lb., lb.	3.39	3.06	3.26	3.66	3.43	3.43	3.66	3.43	3.43
Dressing % (1)	60.8	58.5	59.1	59.1	58.2	60.0	59.1	58.2	60.0
USDA grade (2)	9.6	9.1	10.1	10.0	9.2	10.1	10.0	9.2	10.1
Condemed livers	6	2	6	4	6	3	4	6	3

(1) Calculated from hot carcass weights

(2) 9 equals good +; 10 equals choice -; 11 equals choice average, etc.

Table 8. Summary of Results, Experiment C-28 (126 days - yearlings)

Lot Number	1	2	3	4	5	6
Treatments						
Corn Roughage Pellet %	5	5	5	15	15	15
Potato Pulp %	0	15	25	0	15	25
Initial weight lbs.	693	668	679	661	672	685
Final weight lbs.	1084	1067	1065	1060	1046	1055
Average daily gain lbs.	3.11	3.17	3.06	3.16	2.97	2.95
Feed/day lbs.	25.5	25.8	25.8	25.9	25.5	26.1
Feed/lb. gain, lbs.	8.5	8.1	8.4	8.2	8.6	8.9
TDN/lb. gain, lbs.	5.6	5.5	5.7	5.4	5.6	5.8
TDN c/m/lb., lbs.	3.7	3.7	3.8	3.6	3.7	3.9
Dressing % (1)	60.1	58.7	60.2	60.1	58.3	59.4
Carcass grade (2)	9.8	9.8	9.8	9.5	9.5	8.7
Condemned livers	4	4	4	4	3	3
Vitamin A mg/gm wet liver	6.9	9.9	11.8	3.8	9.8	10.9

(1) Calculated from hot carcass weights

(2) 9 equals good +; 10 equals choice -; 11 equals choice average, etc.

stituting 30 per cent potato pulp for oats (lot 5 vs 2) or a mixture of oats-barley (lot 6 vs 3) did not increase gain nor feed efficiency. In no instance where oats was fed did the cattle increase their intake to compensate for the slightly lower energy content of these rations. Capacity was not the limiting factor. Some other mechanism must regulate voluntary intake of oats, because intake was not on an energy basis.

In order to be able to calculate the TDN per pound of gain and get comparisons on an energy basis instead of pounds of feed during the course of the experiment, a value of 73 per cent TDN was estimated and assigned to the potato pulp. Values of 75 per cent TDN were assigned for the barley and 70 per cent TDN for the oats. In addition, a measure of energy needed per pound of actual gain, corrected by subtracting the requirement for maintenance from the TDN required per pound of gain, was calculated. This measure (TDN c/m/lb) is useful in comparisons and suggests that the 70 per cent TDN assigned to the oats was too low. A more accurate value might have been 72 per cent.

The results obtained from Experiment C-28 are summarized in Tables 8 and 9. In this 126-day experiment (July to November) the yearlings gained much faster than the cattle used in the previous experiment. The average daily gain for all cattle was 3.07 pounds with a standard deviation of 0.48 pounds. This variation in gain was unusually large, but the steers were varied widely in type and condition at the start of the experiment.

As can be seen from the tables, the steers receiving the rations without potato pulp gained only two per cent faster than the steers on the 15 per cent level of potato pulp, and only four per cent faster than those on the 25 per cent level. In terms of feed efficiency they required only two per cent more feed for the 15 per cent level, but five per cent more on the 25 per cent level of potato pulp.

Comparisons of the TDN c/m per pound of gain for the three levels of potato pulp also show similar small trends. It is not possible to ascertain why this slight reduction in efficiency occurred with each increase of potato pulp in the ration.

Table 9. Summary by Treatments, Experiment C-28

Lots:	1,2,3	4,5,6	1,4	2,5	3,6
Treatment	5% CRP (1)	15% CRP	"0" PP (2)	15% PP	25% PP
Average daily gain, lbs.	3.11	3.02	3.14	3.07	3.00
Feed/lb. gain, lbs.	8.3	8.5	8.2	8.4	8.7
TDN/lb. gain, lbs.	5.6	5.6	5.5	5.6	5.7
TDN c/m/lb., lbs.	3.8	3.7	3.6	3.7	3.8

(1) CRP = Corn Roughage Pellets

(2) PP = Potato Pulp

Adding 15 per cent of the corn roughage pellets instead of five per cent increased the feed required per pound of gain by about two per cent. However, when measured by TDN needed per pound of gain after maintenance requirements were accounted for, this difference was shown to be due to size of cattle and not to utilization efficiency of the feed for actual gain.

Results from both experiments indicate that potato pulp can be used effectively up to levels of 25 per cent of the rations for fattening cattle. Because the roughages added in these trials (alfalfa pellets and corn roughage pellets) had both been ground and pelleted, they had less "roughage value" than had they been fed in the long form. In Experiment C-26, where potato pulp was added as 33 per cent of the ration, molasses beet pulp also was added as 5 per cent of the ration. This combination may have contributed to the loose feces. The swelling capacity of the potato pulp upon wetting is greater than for most feeds. When water is added the volume increases by over 130 per cent; that is, it more than doubles in the volume of its water

holding capacity. Beet pulp, measured similarly, increases its volume over 200 per cent. Most cereal grains, such as barley meal, by the same measure increase only by about 30 per cent upon wetting. Thus, in this characteristic, potato pulp acts more like beet pulp than cereal grains. These two factors, the swelling capacity of potato pulp and beet pulp and the fact that the roughage portions of the ration were ground and pelleted, may partly explain the loose feces condition noted in Experiment C-26, but which was not mentioned in the reports by the Canadian or Maine workers. If this be the case, then it is possible that larger percentages of potato pulp could be used if fed with more roughage.

From the calculations and comparison with the other feeds used in this experiment, when used at levels of 25 per cent or less in rations for fattening cattle the TDN value of potato pulp is $72 \pm$ one per cent.

APPRECIATION

Appreciation is expressed to the Red River Starch Company of Grafton, N. Dak., for the potato

pulp and financial grant, to Elanco Products Company of Indianapolis, Indiana for the stilbestrol, and to Commercial Solvents Corporation of Terre Haute, Indiana for the Vitamin A used in these experiments. Thanks are also expressed to Dr. V. K. Johnson and Mr. Paul Berg for obtaining carcass data and to Siouxland Packing Co., West Fargo for cooperation in obtaining carcass data.

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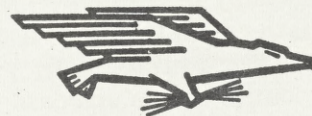
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NORTH DAKOTA STATE UNIVERSITY
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Fargo, North Dakota 58102
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POSTAGE AND FEES PAID
United States Department of Agriculture