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EFFECT OF FEEDING BEET PULP ON MILK PRODUCTION AND FEED UTILIZATION IN DAIRY COWS AND SHEEP

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FEEDING VALUE OF BEET PULP

SULAYMAN

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AN ABSTRACT OF THE THESIS OF

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Title: Effect of feeding beet pulp on milk production and feed utilization in dairy cows and sheep.

Two experiments, using eight Holstein-Fresian cows and eight wether lambs, were conducted to study the effect of feeding high levels of beet pulp on milk production and feed utilization.

The first experiment was a lactation trial of a switch-back design for a period of 12 weeks. The cows were started on experiment when they passed their second month of their respective lactations. The control ration contained 56% barley while the experimental ration contained 55% beet pulp. Cows were fed 4 kg of alfalfa hay per day and concentrate according to their requirements. No significant differences were observed among rations with respect to milk production, milk fat content, gain in body weight and feed consumption.

In the second experiment, three digestion and metabolism trials were carried out to compare the nutritional value of beet pulp to that of corn. Four rations were used in this experiment. The control ration contained 60% corn. In the three experimental rations 50, 75 and 100% of the corn was replaced by beet pulp keeping the proportion of other ingredients constant.

No significant differences were observed in the digestibility of dry matter, energy and crude protein of the four treatments. The crude fiber digestibility increased significantly from 35.41% in the control ration to 55.89, 60.64 and 68.02% in the 30, 45 and 60% beet pulp rations, respectively.

The results of this study indicate that beet pulp, when fed at levels up to 60% of the ration, was comparable to similar levels of corn or barley with respect to milk production and energy utilization.

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I. INTRODUCTION

Agricultural practices in the Middle East are mainly motivated to the production of human food crops rather than livestock feedstuffs. The livestock industry is greatly dependant upon the availability of by-products of certain food industries. Also, for profitable livestock production use of inexpensive feedstuffs is essential.

The successful use of inexpensive human food by-products, as animal feed, contributes to a symbiotic growth of human food of plant and animal origin. One of these feeds is beet pulp. Beet pulp is the by-product left after the extraction of sugar from sugar beets.

In Lebanon a beet sugar factory was established in the Beqa'a area in 1958. Since then, sugar beet production has increased tremendously, from 18,000 tons in 1960 to 100,000 tons in 1966 (Worzella et al., 1966). This inexpensive by-product can be used as animal feed and can replace some of the expensive ingredients used in ruminant rations. The maximum amount of beet pulp that can be successfully used without any adverse effect on production and feed efficiency will determine its importance in feedstuff industry.

Beet pulp is high in fiber for a concentrate, however its fiber is very well digested by ruminants. When molasses is added to beet pulp to lower its fiber proportion, the digestibility is not

increased. The high digestibility and physical appearance of beet pulp categorize it within concentrate feeds. Dried beet pulp is relatively low in fat, phosphorous, carotene and B-Vitamins and so its successful use in the ration will depend upon the correction of these deficiencies, (Morrison, 1959).

Previous work on feeding beet pulp for milk production indicates that when fed at low levels in a dairy ration beet pulp is worth no more than corn (Flatt et al., 1966). However, more research work to investigate the comparative feeding value of beet pulp at higher levels of intake is needed.

The purpose of this study was to find the effect of feeding high levels of beet pulp, as a replacement for the expensive conventional concentrate feeds, on milk production and feed utilization in dairy cows and sheep.

II. REVIEW OF LITERATURE

Production of Beet Pulp

In Lebanon, the production of sugar beet pulp has reached about 60,000 tons per year (Worzella *et al.*, 1966), and is expected to increase with the increase in sugar beet production as a result of improved cultural practices, use of more land and better varieties. Local beet pulp contains 92% moisture after sugar extraction. In preparing the dry product wet beet pulp is first pressed to a moisture level of 85% and then dried to a product containing about 8% moisture in a belt conveyed dryer. No additional treatment is applied. However, in some beet pulp drying factories, additives like lime, molasses or ammonia are added for technical, economical and nutritional reasons. Various kinds of beet pulp have been used for feeding livestock in different parts of the world. They are the following: 1) wet beet pulp, 2) wet pressed beet pulp, 3) dried beet pulp, 4) molassed dried beet pulp, 5) ammoniated beet pulp, and 6) ensiled beet pulp.

The chemical composition of these different kinds of beet pulp are shown in Table 1. The nutrient composition of the dried beet pulp as compared to other common feedstuffs is reported in Table 2.

Table 1. Chemical composition of different kinds of beet pulp[x].

Kind	D.M.	Crude protein	Ether extract	Crude fiber	N.F.E.	Ash	Ca.	P.	TDN
					%				
Dried beet pulp	91.2	8.8	0.6	19.6	58.7	3.5	0.69	0.08	68.7
Dried molassed pulp	92.2	8.9	0.5	15.2	61.8	5.8	0.57	0.07	72.4
Wet beet pulp	11.6	1.5	0.3	4.0	5.3	0.5	0.09	0.01	8.8
Pressed wet beet pulp	14.2	1.4	0.4	4.6	7.1	0.7	-	-	10.8
Ensiled beet pulp	12.0	1.7	0.4	5.2	4.3	0.4	-	-	9.0

D.M. = Dry Matter ; N.F.E. = Nitrogen Free Extract ; Ca. = Calcium ; P. = Phosphorous
TDN = Total Digestible Nutrients

x. From Morrison's Feeds and Feeding, 1959.

Table 2. Comparative composition of certain feedstuffs[x].

Nutrients		Feedstuffs			
		Dried beet pulp	Corn	Barley	Alfalfa hay
D.M.	%	92.2	87.0	89.3	90.5
Crude protein	%	8.9	8.9	11.8	15.3
Ether extract	%	0.5	4.0	1.9	1.9
Crude fiber	%	15.2	2.0	6.2	28.6
NFE	%	61.8	70.8	66.2	36.7
Ash	%	5.8	1.3	3.2	8.0
Ca	%	0.57	0.02	0.06	1.47
P	%	0.07	0.28	0.33	0.24
Net E/100 lb in therms		71.6	81.4	70.5	40.6
Vit.A activity I.U./lb		167	2167	333	13667
B complex Vits. Mg/lb		377	200.17	451.93	0.08

x. From Morrison's Feeds and Feeding, 1959.

Nutritional Value of Beet Pulp

Wet Beet Pulp

Henderson and Teague (1933) found that when dairy cows were given free access to water, there was no appreciable difference in the feeding value of either wet or dried beet pulp with respect to milk yield, milk fat percentage, gain in body weight and water consumption.

Utah workers found that cows fed wet beet pulp as a substitute for corn silage produced as much milk as those fed the silage. Lamb fattening trials by Wyoming workers showed more economical gains with wet beet pulp than with dried beet pulp or ground alfalfa used with a basal diet of barley and alfalfa hay. Colorado workers compared wet beet pulp with dried beet pulp and molasses beet pulp in a basal diet of grain and alfalfa hay in lamb fattening experiments. They found that one ton of wet beet pulp replaced 222 pounds of corn and 208 pounds of alfalfa hay. Idaho workers found that when wet beet pulp was fed at the rate of 1.75 lb s per day to fattening lambs, one ton of the wet pulp replaced 426 lbs of alfalfa hay and 90 lbs of barley (Oltjen, 1969).

Beet Pulp Silage

Novikov et al. (1968) fed two groups of cows, in their second month of lactation, different amounts of ensiled beet pulp for a period of 110 days and found that amount of ensiled beet pulp had no significant effect on milk yield. When the amount of silage fed was increased from 10- to 30-kg per day, fat and protein content

of the milk were reduced significantly.

Demchenko and Pechkurova (1967) reported that ensiled sugar beets were as effective as fresh beets in the ration of dairy cows, so far as the milk yield, butter fat content and body weight gain were concerned.

Manuelian (1965) compared dried sugar beet pulp with ensiled sugar beet pulp for fattening young bulls. He found that the dried beet pulp group had a higher daily gain than the silage group, but the difference was not statistically significant. The beet pulp group also had the highest feed consumption on dry matter basis but the silage group had the highest feed efficiency.

Dried Beet Pulp and Molassed Dried Beet Pulp

Huffman and Duncan (1950) found a significant increase in fat corrected milk (FCM) when various levels of dried beet pulp or sugar beets replaced an equal amount of total digestible nutrients (TDN) in the all-alfalfa hay ration for dairy cows. They also observed a tendency of the percent butter fat to increase when beet pulp or sugar beets replaced an equal amount of TDN in the hay. From these results, they concluded that the "so-called" grain factor (S) or the unidentified milk-stimulating factor (S) were also stored in beet pulp and sugar beets.

Ronning and Bath (1962) compared the effect of feeding three different kinds of dried beet pulp with that of barley on milk production of dairy cows. The kinds of beet pulp used were: 1) dried beet pulp, 2) molassed dried beet pulp, and 3) concentrated steffen filtrate dried beet pulp. They observed that each of the three

kinds of beet pulp was equal to barley in the replacement of approximately 25% of the energy of a basal ration consisting of 70% lucerne hay and 30% barley.

Castle et al. (1966) studied the effect of feeding dried sugar beet pulp to 15 Ayrshire cows for a period of 15 weeks. In this trial all cows received silage three times daily, and concentrate. Two levels of beet pulp in the concentrate mixture were compared with a no beet pulp concentrate ration. The levels of beet pulp used were 6 and 12 lbs in the daily ration. Milk production increased steadily at each increase in the level of beet pulp but there was no significant difference in the fat content of the milk. The solids not fat (SNF) of the milk increased significantly with the inclusion of beet pulp. They also reported that the addition of beet pulp had no adverse effect on the taste of milk.

Koetsveld et al. (1955) found that the substitution of dried sugar beet for an equivalent weight of the ordinary dried beet pulp in the rations of dairy cows raised the feed cost. No difference in milk yield, fat content of the milk or body weight was observed.

Ammoniated Beet Pulp

In comparing the feeding values of rations containing 1) cotton seed meal, 2) ammoniated beet pulp, 3) urea, and 4) beet pulp saturated with ammonium lactate, Bielinski (1966) found that the mean daily yield of 4% FCM was 23.3, 19.7, 22.4 and 21.0 kg, respectively. Milk fat percentage increased in ammonium lactate and urea groups only. There was significant difference in digestibility

and nitrogen balance between the groups.

Burzinski (1966) used nine cows in three groups of three each to determine the value of ammoniated beet pulp. The cows were fed rations in which portions of crude protein ranging from 94- to 363-g were replaced by the same amount of nitrogen as ammonia. The substitutions were attained by using 1.5- to 6.0-kg of dry ammoniated sugar beet pulp in the daily ration. He found that protein digestibility, N - balance and daily milk yield were decreased at the higher levels of substitution.

Ruminants and Concentrate Feeding

The fairly high content of digestible nutrients and its physical form classify dried sugar beet pulp as a concentrate feedstuff.

High level concentrate feeding usually results in increases in milk production, mainly due to greater intake of energy at the time of high requirement. However, it should be remembered that unlimited concentrate feeding does not always increase production and may result in digestive disturbances which lead to off-feed condition and acidosis.

Brown et al. (1962) divided 18 lactating dairy cows into three comparable groups approximately 36 days postpartum to study the effect of feeding high levels of grain for a complete lactation. Grain was fed at three levels: Group 1, 1.0 lb grain/3.5 lb milk, Group 2, 1.0 lb grain/2.5 lb milk and Group 3, grain ad libitum. They found that the cows fed the two higher levels of grain produced considerably more milk than expected during the first part of

lactation and cows fed the low level of grain produced slightly less milk than expected. The same relationship held true for fat percentage, S.N.F. and daily gain in body weight.

Kesler and Saphr (1964) in a review of physiological effects of high level concentrate feeding, pointed out that high level concentrate feeding usually results in increases in milk production mainly caused by greater intake of energy.

Coppock et al. (1964) have shown that for maximum efficiency of utilization of metabolizable energy the ratio of concentrate to hay had to be at least 1:1.

Swanson et al. (1967) when comparing restricted vs ad libitum roughage diets found that diets that averaged 67.6% concentrate were used less efficiently than diets which averaged 51.1% concentrate. They added, that restricting roughage and substituting concentrate TDN for roughage TDN resulted in lower milk fat tests and feed efficiency.

Richardson et al. (1961) conducted heifer feeding trials during three years with rations having roughage to concentrate ratio of 1:1, 1:3 and 1:5. They reported that the highest average gain was obtained with a 1:5 ratio ($P < 0.05$) and lowest with a 1:1 ratio. Crude fiber digestibility was highest with 1:3 ratio and protein digestion was not affected by changes in the roughage to concentrate ratio.

In energy balance measurements of Holstein cows consuming rations containing 60, 40 or 20% alfalfa hay with respectively 40, 60 or 80% corn-soybean meal mixture, Flatt et al. (1966) found that

the proportion of gross energy (G.E.) lost in feces and methane, decreased ($P < .01$) with increasing proportions of concentrates in the rations. They added that an opposite trend was apparent in the percentage G.E. lost as heat, but was significant only in trials where feed intake was restricted.

III. MATERIALS AND METHODS

Experiment I

Animals

Eight Holstein - Fresian Cows, averaging 560.70 kg in body weight, from the AREC dairy herd were used in this experiment. The years of lactation of the cows ranged from first to fourth. The experiment began when the cows passed their peak milk production in their second month of respective lactations.

Housing

It consisted of a closed barn with five equalized stalls having a concrete floor. Each stall was equipped with an automatic water cup for free access to water. The cows were restrained in the individual stalls by means of chains, so as to have an easy access to their respective troughs. Wood shavings was provided as bedding.

Experimental Design

Cows were randomly alloted to two treatments using a switch back design. Each trial consisted of three periods of four weeks each. Every animal was subjected to the same treatment during the first period and the third period of the trial. In the second period the animal was subjected to the alternate treatment. In each period data were recorded only during the last three weeks. The first week was considered as a transitional phase for ration adjustment.

Diets Studied

Dried beet pulp was obtained from Angar sugar factory and stored on the AREC. A representative sample was analysed for proximate and mineral composition.

The composition of the rations used in this experiment is shown in Table 3. Barley and beet pulp were the main energy sources in the control and the experimental rations, respectively. Cotton seed meal (C.S.M.) was used as the protein supplement of the control ration which contained 15% crude protein. Wheat bran was added to the experimental ration in an attempt, to make it economical. Since the wheat bran could not provide all the protein needed, about 15% peanut oil meal (P.O.M.) was added in the experimental ration to make it equiproteinic to the control ration. Peanut oil meal was chosen because of its high protein content and its inclusion in lower proportions raised the protein content of the ration to the desired level. The use of two different kinds of oil seed meal in the rations is subject to criticism. However, the main interest of this investigation was the comparison of two energy sources and not of two protein supplements in the ration. Also in ruminants the quality of the proteins according to their amino acid make up does not play a significant role in their utilization.

In an attempt to balance the calcium and phosphorous content of the rations, limestone was added to the control ration.

Feeding Plan

The animals were fed individually, about 4 kg of alfalfa hay each, per day, and concentrate mixtures according to their daily

Table 3. Ingredient and chemical composition of concentrate rations. Experiment I.

Ration No.	I	II
Ingredient compontion (%)		
Beet pulp	10.18	54.73
Barley	57.03	-----
Wheat bran	6.11	29.85
P.O.M. (46%)	-----	14.93
C.S.M. (30%)	25.46	-----
Limestone	0.71	-----
Salt	0.51	0.5
Chemical compontion (%)		
Moisture	10.42	8.91
Crude protein	15.08	15.48
Crude fiber	11.78	15.51
Ether extract	3.27	1.42
Ash	4.14	3.85
Nitrogen free extract	55.31	54.83
Calcium	0.422	0.587
Phosphorous	0.557	0.436

requirement (NRC, 1958). The alfalfa hay used was produced at the AREC and contained about 15% Crude Protein on a dry basis. The hay was fed twice daily, in equal portions in the morning at 9 a.m. and in the afternoon at 4 p.m. Required amounts of concentrate mixtures were fed to the cows at different hours of the day including milking hours. Daily feed consumption was recorded taking into account any weigh back left at the end of the day. Feed samples were taken during the entire experimental period and composited for analysis.

Growth and Lactation Record

All cows were weighed on three consecutive days every week and the average was recorded as weekly weight.

The amount of milk produced was recorded at each milking. Milk samples were collected three times a week on every other day. The milk samples were composited and preserved with potassium dichromate. These samples were then analyzed for percent fat applying Babcock Procedure.

Analyses

Proximate and mineral analyses of feedstuff and rations were conducted according to A.O.A.C. methods (1960). Statistical analyses of all data were obtained according to Snedecor (1962).

Experiment II

Animals

Eight, four month old wether lambs averaging 26 kg in body weight were used in this study. The lambs were sheared and their

hoofs trimmed at the beginning of the experiment.

Housing

The animals were kept in metabolism stalls about two weeks prior to the experiment for adjustment to the new environment. The metabolism stalls were made at the AREC carpentry shop according to a modified design, (Briggs and Gallup, 1949), which enabled complete collection of feces and urine separately.

Experimental Design

The eight lambs were divided into two blocks of four each. Four rations were randomly alloted to the four sheep in each block in every trial. Each trial consisted of a ten-day preliminary period followed by a seven-day collection period, during which total feces and urinary collections were made. On the day following completion of the collection period blood samples were taken from the Jugular vein two hours after the beginning of morning feeding.

Diets Studied

Four rations containing, 0, 30, 45, and 60% beet pulp were studied. The control ration consisted of (a) 60% ground corn and (b) 40% of a mixture containing wheat bran, P.O.M., alfalfa hay, salt, limestone, and bone meal. The (b) component was the same in all rations. In ration 2, 3 and 4, 50, 75 and 100% of the (a) component was replaced by beet pulp. The proportions of limestone and bone meal varied between rations as a result of the addition of beet pulp which is high in calcium and low in phosphorous. Alfalfa hay provided the fibrous bulk for proper rumen function. P.O.M. was the

protein source in all rations. Wheat bran was the same in all rations, it added to the protein content and balanced the phosphorous content especially when beet pulp was added. Vitamin A and D were added to all rations.

Feeding Plan

Animals were fed twice a day at 8:00 a.m. and 2:00 p.m. for 2½ and 3 hours, respectively. Water was available to the sheep whenever feed was not. The animals were fed about 20% more than usual intake and weigh back was recorded once at the end of each day.

Collection and Analyses

Feed samples were collected during the entire experiment and composited for later analyses. The feed refused during the entire collection period was composited and then sampled for analyses. During the seven-day collection period, feces was collected once daily and dried in an oven at 55°C for 24 hours. At the end of the collection period the total amount of feces voided by every lamb was weighed and a representative sample was taken for analysis. Urine collection was conducted according to the procedure suggested by Bhattacharya and Fontenot (1965). Feed and feces were analyzed for proximate components according to A.O.A.C. (1960) methods. Urine was prepared for energy determination by drying a sample in a mechanically refrigerated freeze dryer following the procedure of Paladine et al. (1964). Energy determinations were made using about 0.5 g of a representative sample of urine solids. Energy determinations for

feed, feces and urine were made by using Ballistic bomb calorimeter. Digestion coefficients for various components of the rations including energy were calculated. From these coefficients, TDN, digestible protein and digestible energy contents were calculated.

Methane production was calculated using the formula of Swift et al. (1948). Metabolizable energy (M.E.) values of the rations were expressed as percent of gross energy.

Blood glucose and total volatile fatty acids (VFA) were determined according to the method of Folin and Wu (1920) and Annison (1954), respectively.

The data were subjected to statistical analyses according to Snedecor (1962) and the multiple range test (Duncan, 1955) was used to test for significant difference among treatments.

IV. RESULTS AND DISCUSSION

Experiment I

Purpose

The objective of this study was to determine the relative efficiency of an inexpensive ration containing high levels of beet pulp supplemented mostly with wheat bran and a conventional high concentrate ration containing barley supplemented with an oil seed meal, in terms of milk production and maintenance of the health of dairy cows.

Results and Discussion

The chemical composition of dried sugar beet pulp, corn, barley and alfalfa hay are presented in Table 2. The protein content of beet pulp is almost as that of corn but slightly less than that of barley. The fat content of corn and barley compared to beet pulp is eight and four times higher, respectively. Beet pulp has a high fiber content when compared to corn and barley, but the fiber is well digested by ruminants. Beet pulp is rich in ash content but has comperatively higher calcium and lower phosphorous contents, a phenomenum which is not true in case of grain feeds. Also, beet pulp is low in carotene and certain B-vitamins, (Morrison, 1959).

The chemical analyses of the rations presented in Table 1 show that both rations were approximately equiproteinic. The crude

fiber content of the experimental ration was higher than that of the control ration. Morrison (1959) reported that crude fiber digestibility of beet pulp is high and thus it was felt that this difference would not have an adverse effect on the production of the animal. The fat content of the experimental ration was lower than that of the control because of the low fat percentage of the beet pulp. The mineral content and calcium-phosphorous ratio were in agreement with those recommended by N.R.C. (1958).

Kromann (1966) reported that maximum digestible energy (D.E.) was obtained from concentrate rations when the amount of roughage feeding was restricted. However, feeding high level of cereal concentrates in a roughage restricted ration has often caused digestive disturbance and off-feed condition due to acidosis from excessive lactic acid production. In this study the amount of roughage was restricted to about 4 kg of alfalfa hay per day. The crude fiber in the beet pulp was expected to add bulk to the ration and thereby to prevent any adverse effect of high concentrate feeding. Furthermore, the beet pulp crude fiber could be used because of its high digestibility. The water intake of cows was about the same for both rations. This was in agreement with the findings of Henderson and Teague (1933) when they compared water intake following feeding wet or dried beet pulp. No clinical symptoms of bloat or other digestive disturbances were observed in cows during the experimental period.

Average daily feed intake, milk production, fat percentage and body weight gain data are presented in Table 3.

Feed Intake

The animals readily consumed the rations offered. The amount of concentrate taken by the cows was corrected weekly according to N.R.C. (1958) requirement. This procedure was applied by Hooven et al. (1965) and showed that cows fed at a uniform rate produced less FCM and consumed less energy than those fed according to their current TDN requirement. Both rations were palatable and acceptable by the cows during the experimental period. However, Jorgensen and Schultz (1963) reported that dried beet pulp was not palatable, as compared to corn, and feed intake dropped when offered to dairy cows in a basal ration of alfalfa hay ad libitum.

Gain in Weight

There was no significant difference in body weight gain between treatments. This suggests that the rations fed supplied the required nutrients needed for maintenance and growth of the animals. The low value in the barley group was mainly due to the weight loss of one particular cow, and cannot be explained.

Milk Production

Table 4 shows that there was no significant difference in the amount of 4% F.C.M. produced. Five out of eight cows showed a trend toward higher milk production on the high beet pulp ration. The finding of no adverse effect on milk production in cows fed rations containing 55% beet pulp is very encouraging and throws new lights in the research area of studies on inexpensive high concentrate rations for dairy cattle. Most of the previous workers did not use large

Table 4. Response of lactating dairy cows to barley and beet pulp rations.

Average daily performance	Groups[x]	
	Barley	Beet pulp
Concentrate intake, kg	13.97	14.01
Hay intake, kg	3.86	3.86
Body weight gain, kg	- 0.58	+ 0.73
Milk, kg	18.25	18.11
Milk fat (%)	3.66	3.81
4% FCM kg	17.32	17.59

x. Values are not significant.

proportion of beet pulp. This finding could be due to the fact that the energy values of beet pulp and barley compare very well as suggested by Lofgreen et al. (1962), and using high levels of dried beet pulp did not seem to reduce its energy value. However, Jorgensen and Schultz (1963) reported that cows fed alfalfa hay ad libitum and offered 20 lb of beet pulp produced significantly less milk than a control group fed 16 lb of corn. Ronning and Bath (1962) compared beet pulp and barley and found no significant difference with respect to milk production.

Milk Fat Content

The milk fat content was higher on the high beet pulp ration. Six out of eight cows showed an increase in fat percentage when fed the experimental ration, but these increases were not significant. Usually, when animals are fed high concentrate rations the fat percentage is expected to drop (Kesler and Saphr, 1964), unless enough roughages are fed to maintain the high fat content of the milk. Jorgensen and Schultz (1963) found that milk fat percentage was lower in a control group fed alfalfa hay and 16 lb of corn than in a group fed alfalfa hay and 20 lb of beet pulp. Castle et al. (1966) reported no significant difference in the fat content of milk produced by cows fed either 6 lb or 12 lb of beet pulp along with silage. It is interesting to note that inspite of the lower fat content of the beet pulp as compared to barley, there was no effect of the dietary fat restriction on milk fat production. Van Soest (1963) has shown that inclusion of fat in the diet had no effect on milk fat content.

The results of this experiment tend to indicate that beet pulp,

up to the level of 55% in a concentrate dairy ration, is comparable to barley so far as FCM production is concerned.

Experiment II

Purpose

The objective of this study was to determine the utilization of beet pump nutrients at different levels in ruminant rations.

Results and Discussion

Table 5 shows that 40% of the rations were the same, so the metabolites coming out of the mixture will have negligible effect on the digestibility and utilization of beet pulp and corn when comparing the four rations. Crude fiber and ether extract content of the rations increased and decreased respectively as the proportion of the beet pulp increased in the ration. Calcium and phosphorous contents of the rations were not much different.

The lambs were fed high concentrate diets and no digestive disturbances or off-feed conditions due to acidosis were noticed. The high rumen acidity often observed on high level of concentrate feeding is due to the availability of readily fermentable carbohydrates which result in more production of lactic acid, (Walso and Schultz, 1956; Brigs, et al., 1957; Elsden, 1946; Philipson and McAnally, 1942). In this study the absence of any such problems is interpreted as an indication of the suitability of the experimental rations probably because of the bulk contributed by beet pulp. The lambs fed the control ration did not show any digestive disturbance because none of the lambs was fed the control ration for a long time

Table 5. Ingredient and chemical composition of rations. Experiment II.

Ration No.	I	II	III	IV
Ingredient composition (%)				
Corn	60.0	30.0	15.0	----
Beet pulp	----	30.0	45.0	60.0
Wheat bran	23.0	23.0	23.0	23.0
F.O.M.	5.0	5.0	5.0	5.0
Alfalfa hay	9.0	9.0	9.0	9.0
Salt	0.5	0.5	0.5	0.5
Limestone	2.0	1.0	0.5	0.25
Bone meal	0.5	1.5	2.0	2.25
Chemical composition (%)				
Moisture	13.24	11.87	11.24	10.66
Crude protein	12.53	12.96	13.03	13.96
Crude fiber	6.67	10.94	12.67	16.20
Ether extract	1.41	1.18	1.09	0.86
Ash	5.07	6.25	5.94	5.88
N.F.E.	61.08	56.80	56.03	52.44
Calcium	1.37	1.96	1.85	1.64
Phosphorous	4.477	0.503	0.546	0.476
Energy Cal/g	4.00	4.06	3.87	3.92

as compared to beet pulp groups.

Although palatability tests were not conducted in the experiment, acceptance of all rations by the lambs did not present any problem.

Digestion Coefficients

Apparent digestion coefficients for the four rations are presented in Table 6. Dry matter digestibility did not differ significantly among treatments. The D.M. digestibility of the control ration was 77.92%, while that for the high level beet pulp ration was 76.99%. Crude protein digestibility of the rations was not significantly different and this could mean that the protein of beet pulp was as well digested as that of the corn. However, Morrison (1959) reported higher digestible coefficients for proteins coming from corn than that of those coming from beet pulp.

Crude fiber digestibility showed significant differences among treatments. Crude fiber digestibility increased at each increase in the level of beet pulp. This seems to be due to the fact that the crude fiber from beet pulp is highly digestible. This was in agreement with most reports about the digestibility of crude fiber by ruminants. However, Kesler and Saphr (1964) reported lower digestibility of crude fiber of high concentrate rations due to change in rumen fermentation as a result of lower numbers of cellulose utilizing microbes and protozoa due to high rumen acidity under high grain feeding conditions. The higher digestibility of crude fiber in beet pulp may possibly be attributed to absence of lignin deposition in the fiber. Crampton and Maynard (1938)

Table 6. Apparent digestion coefficients of the rations.

Ration Beet pulp level, %	I 0	II 30	III 45	IV 60
Apparent digestibility %				
Crude protein	74.68	71.23	72.04	74.78
Crude fiber	33.41[a]	55.89[b]	60.64[b]	68.02[c]
Ether extract	61.49[a]	47.74[b]	36.44[b]	18.54[c]
NFE	85.72	83.68	84.04	83.51
Dry matter	77.92	75.92	76.18	76.99
Energy	78.37	77.63	75.53	76.16

a, b, c. Figures having different subscripts in the same row are significantly different, ($P < 0.01$).

indicated that digestibility of actual cellulose was much higher than the lignified cellulose found in the forage crops.

There was a highly significant difference ($P<0.01$) among treatments with respect to fat digestibility. The digestibility of fat increased as the proportion of corn increased in the rations. The fat content of corn is about eight times as that of beet pulp. The low fat content of the beet pulp ration might have shown a decline in digestibility, Perhaps due to metabolic fat and non-fat but ether extractable compounds excreted in feces, (Crampton, 1959).

No significant differences among rations were observed for the digestibility of NFE, digestible and metabolizable energy. The digestible and metabolizable energy of the rations containing 0, 30, 45 and 60% beet pulp were, 3130, 3150, 2920, 2980 Kcal/kg and 72.65, 72.32, 69.77 and 70.38%, respectively. The most significant result of this experiment was finding that the energy of beet pulp was comparable to that of corn, a cereal grain considered to be one of the best energy sources. However, Morrison (1959) reported lower values of TDN and energy for beet pulp than those for corn or barley.

Blood Glucose and VFA's

Blood VFA levels showed no significant differences among rations. Also, blood glucose analyses did not show any significant difference among treatments, (Table 13). This finding could mean that the carbohydrate content of the rations were not much differently utilized.

The results of this experiment show that beet pulp nutrients can be well utilized by ruminant animals. But, further studies should

be made with higher levels of beet pulp with lower levels or even without roughage in a trial to observe the adverse effect(s) of high beet pulp feeding if any.

V. SUMMARY AND CONCLUSIONS

Two experiments were conducted to study the effect of feeding high levels of beet pulp on milk production and feed utilization in dairy cows and sheep.

A lactation trial involving eight cows in a switch back design was conducted for a period of three months to study the feeding value of beet pulp on milk production. A control ration containing 56% barley was compared to an experimental ration containing 55% beet pulp. When cows were fed the concentrate rations and 4 kg of alfalfa hay no significant differences in weight gain and fat corrected milk production were observed.

In the second experiment, three trials were conducted with eight wether lambs to study the digestibility and energy utilization of beet pulp when fed at four different levels. The control ration contained 60% corn and no beet pulp. In the three experimental rations 50, 75 and 100% of the corn in the control ration was replaced by beet pulp, keeping the proportion of other ingredients constant. No significant differences were observed in the digestibility of dry matter, energy and crude protein among the four treatments. The digestible energy of the rations containing 0, 30, 45 and 60% of beet pulp were 3130, 3150, 2920 and 2980 Kcal/kg. Thus the beet pulp energy was as well digested as corn even up to a level of 60% in the ration. Crude fiber of beet pulp was highly digestible and the

digestibility increased significantly ($P < 0.01$) from 35.41% in the control ration to 55.89, 60.64 and 68.02% in the 30, 45 and 60% beet pulp rations, respectively. The metabolizable energy content of the rations expressed as percent gross energy were 72.65, 72.32, 69.77 and 70.38 in the 0, 30, 45 and 60% beet pulp rations, respectively. These values were not significantly different from each other.

The results of this study indicate that beet pulp when incorporated at a level up to 60% in the ration showed no significant difference in milk production and energy utilization in dairy cows and sheep when compared to rations containing similar levels of corn or barley.

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APPENDICES

Table 7. Daily average milk production, fat percentage, body weight and feed consumption as influenced by the kind of ration.

		Cow's number							
		33	58	43	47	63	42	49	64
F.C.M. in kg	Barley	17.32	14.78	18.16	18.29	13.56	24.14	16.73	15.61
	Beet pulp	18.81	13.93	17.27	18.54	15.07	22.63	18.63	15.84
Fat percentage	Barley	4.20	3.47	3.67	3.45	3.40	4.13	3.40	3.57
	Beet pulp	3.87	3.80	3.72	3.73	3.67	4.00	4.08	3.58
Body weight in kg	Barley	621.37	532.53	568.67	589.17	467.58	540.00	578.00	485.00
	Beet pulp	653.67	544.78	580.33	583.33	465.67	531.67	565.00	494.58
Concentrate in kg	Barley	14.09	11.51	14.85	15.83	11.14	18.86	13.64	11.82
	Beet pulp	16.68	11.06	14.39	15.15	11.51	17.58	14.39	11.97

Table 8. Summary of analysis of variance for Experiment I.

Source	D.F.	Milk	Fat percentage	Body weight	Feed
		m.s.	m.s.	m.s.	m.s.
Treatment	1	4865.91	6.84	6066.53	820.12
Error	6	15888.37	3.29	9159.85	13730.46
Total	7	20754.28	10.13	15226.38	14550.58

Table 9. Digestibility of beet pulp nutrients.

Level, %	30	45	60
Digestibility %			
Crude protein	63.18	68.81	74.84
Crude fiber	103.66	91.46	89.76
Ether extract	15.66	5.82	-10.09
NFE	78.92	81.99	82.04
Dry matter	71.25	74.05	76.37
Energy	75.90	72.06	74.69

Based on method outlined by Crampton and Lloyd (1959). Basic equation: $S = \frac{100\ (T-A)}{s} + A$

(S = digestible coeff. of beet pulp; T = digestible coeff. of beet pulp rations; A = digestible coeff. of control ration; s = percent of beet pulp in the ration).

Table 10. Total digestible nutrients, digestible protein, digestible energy and metabolizable energy in Experiment II rations.

Ration No.	I	II	III	IV
TDN	66.04	64.13	65.06	65.61
D.P. (%)	9.35	9.23	9.39	10.44
D.E. Kcal/kg	3130	3150	2920	2980
M.E. (% Gross Kcal.)	72.65	72.32	69.77	70.38

Table 11. Total digestible nutrients and metabolizable energy of various levels of beet pulp.

Level %	30	45	60
TDN	59.67	63.86	65.32
M.E. Kcal.	71.55	66.25	68.87

Table 12. Summary of analysis of variance for Experiment II.

Source	D.F.	Apparent digestibility (%)					
		C.P.	C.F.	E.E.	NFE	D.M.	D.E.
		m.s.	m.s.	m.s.	m.s.	m.s.	m.s.
Treatment	3	19.82	1171.91^{xx}	1981.18^{xx}	6.18	4.88	10.22
Trial	2	13.61	373.98^{xx}	272.08	5.47	31.28^{x}	34.36^{xx}
Block within trial	3	0.28	4.89	1.64	0.25	0.14	0.02
Error	15	10.24	29.77	65.36	4.43	5.61	4.36
Total	23	43.95	1580.55	2340.26	16.33	41.91	48.96

x. P (< 0.05)

xx. P (< 0.01)

Table 13. Blood glucose and VFA data in Experiment II.

Ration	I	II	III	IV
Beet pulp level, %	0	30	45	60
Glucose (mg/100 ml)	38.75	36.92	47.50	53.17
VFA (meq/100 ml)	0.136	0.345	0.391	0.284

Appendix B

Abbreviations

Agricultural Research and Education Center	AREC
and others	et al.
Association of Official Agricultural Chemists	A.O.A.C.
Calcium	Ca.
Calorie(s)	Cal.
Centigrade	^{o}C
Cotton seed meal	C.S.M.
Digestible energy	D.E.
Degrees of freedom	d.f.
Dry matter	D.M.
Energy	E
Fat correct milk	FCM
Gram(s)	g
Gross energy	G.E.
International unit(s)	I.U.
Kilocalorie(s)	Kcal
Kilogram(s)	kg
Metabolizable energy	M.E.
Number	No.
Nutrition Research Council	NRC
Nitrogen free extract	NFE

Peanut oil meal	P.O.M.
Percent	%
Phosphorous	P
Pound(s)	lb
Solids not fat	S.N.F.
Total digestible nutrients	TDN
Volatile fatty acid(s)	VFA