JOURNAL OF THE SCIENTIFIC AGRICULTURAL SOCIETY OF FINLAND
Maataloustieteellinen Aikakauskirja
Vol. 49: 315—329, 1977

A polyol mixture or molasses treated beet pulp in the silage based diet of dairy cows

I. The effect on the feed utilization, milk yield and blood values

MIKKO TUORI and ESKO POUTIAINEN
Department of Animal Husbandry, University of Helsinki, 00710 Helsinki 71

Abstract. This study investigated the effect of a polyol mixture or molasses treated beet pulp on the feed utilization, milk yield and blood values. 24 cows were divided into 3 groups. Hay was given at 2 kg/d, silage ad lib. and concentrate mixture at 7—8 kg according to the milk yield. The control group had grain (barley-oat) concentrate mixture, the molasses group had grain supplemented with 29 % dried molasses beet pulp and for the polyol group grain was supplemented with 25 % dried beet pulp treated with mixture of sugar alcohols.

A 2 weeks standardisation period was followed by 12 of comparison. 12 of the cows were also in a digestibility trial in the later part of the comparison period.

Feed intake was heavily reduced in the molasses group and hence the milk yield was significantly lower ($P < 0,05$) than in the polyol or control groups (19,5, 21,2 and 21,2 kg FCM/d). The mean consumption of polyols was 483 g/d and that of sugars from the molasses beet pulp was 410 g/d. The feed utilization was significantly lower ($P < 0,05$) in the control group than in the polyol or molasses groups. The consumptions of f.f.u./kg FCM were correspondingly 0,407, 0,375 and 0,373.

Digestibility of nitrogen free extracts was significantly higher for the polyol group than for the control group (81,4 and 78,1 %). For molasses group digestibility of NFE was 78,5 %. Digestibility of OM was correspondingly 76,2, 73,6 and 74,3.

Rumen butyric acid formation was higher in the polyol group than in the molasses or control groups, although the differences were not statistically sinificant.

The blood and plasma parameters studied were haemoglobin, PVC, ketone bodies in blood, glucose, total protein, urea-N and uric acid in plasma.

Plasma urea-N was higher ($P < 0,01$) in the control than the polyol or molasses groups. In glucose or ketone bodies concentration there were no treatment induced differences.

Introduction

Sugar alcohols, or polyols, of which the best known are xylitol and sorbitol, are derivatives of sugars and are widely used in human nutrition as, for instance, sweetening substances and in the parenteral nutrition of diabetics. The use of xylitol as a sweetening substance has increased after it was notices that the substitution of sugar with xylitol significantly decreased the incidence of dental

caries in man. The inhibitory effect on formation of caries based on the decreasing of microbial growth in the mouth (SCHEININ and MÄKINEN 1975).

Rumen microbes ferment polyols slower than sugars. CZERKAWSKI and BRECKENBRIDGE (1969) noticed that after 1 hour of incubation in rumen liquid, in vitro, mannitol was fermented 3,0 and sorbitol 2,9 %. Sucrose was fermented 21,6 and glucose 23,6 %. POUTIAINEN et al. (1976) noticed that after 4 hours of in vitro incubation (in rumen liquid from a cow, to whose rumen was infused a polyol mixture) that xylitol, arabinitol, galactitol, mannitol and sorbitol were under 10 % fermented and glucose a little over 40 %. Incubation in the liquid taken from non-adaptated cow gave yet less fermentation. Xylitol or a mixture of polyols infused into the rumen flow little into the duodenum (TUORI and POUTIAINEN 1978). Thence, while in the rumen unfermented polyols are probably to be absorbed through the rumen wall.

The absorption of polyols from the intestinal tract is much slower than that of sugars. One hour after application, in rats, xylitol and sorbitol absorption was under 20 %, while galactose, glucose, sucrose and fructose were absorbed almost completely (DEHMEL et al. 1969). Adaptation increases the speed of absorption (BÄSSLER 1969). The secretion of labelled ^{14}C in urine following ^{14}C-xylitol treatment is 3—4 % with both adapted and non-adapted rats (SCHMIDT et al. 1964). The secretion of labelled carbon from arabinitol in urine was 36—38 % with rats (MCCORMICK and TOUSTER 1961).

Xylitol, an intermediate of the glucuronic acid pathway, enters the glycolytic and gluconeogenic pathways via the pentose shunt. Sorbitol and mannitol are metabolized via fructose in the liver. Over 80 % of fructose, xylitol and sorbitol are metabolized in the liver. In a rat liver preparation 60—70 % of added xylitol was obverved to change to glucose and, of sorbitol and fructose, only 45—50 %. In the live animal about 50 % of intravenously infused carbohydrates were found to have been stored in the form of glycogen. When looking at the precursors of glucose (xylitol, fructose and sorbitol), maximum glycogen deposition is up to 50 % higher than when looking at glucose (FÖRSTER et al. 1972, ref. FÖRSTER 1976). After feeding ^{14}C-xylitol to rats approximately 60 % of the labelled appears as respiratory $^{14}CO_2$ (SCHMIDT et al. 1964). From peritoneally administered ^{14}C-arabinitol 13 % was found as respiratory CO_2 and 1—3 % as glucogen (MCCORMICK and TOUSTER 1961). The utilization of sugars and polyols infused intravenously to man was 100 % with glucose, 99 % with fructose, 89 % with sorbitol and 84—88 % with xylitol (MATZKIES 1974, BERG et al. 1975).

Glyserol, sorbitol and xylitol reduce the formation of ketone bodies in the liver. Galactitol and mannitol are ineffective (TODD 1954, HAYDON 1961). Glucose, fructose, sorbitol, xylitol and glyserol also inhibit ketogenesis upon infusion of a fatty acid, tentatively indicating that an antiketogenic effect of these compounds in the liver is independent of their action on lipolysis. It is assumed that this effect is the result of the inhibition of gluconeogenesis and/or the production of oxaloacetate (BÄSSLER and BRINKROLF 1971).

In bovine ketosis aetiology there is the view that a fall in the concentration of oxaloacetate, associated with high rates of gluconeogenesis, is a major causative factor (KREBS 1966, BAIRD 1968, BERGMAN 1971). The widely used

prophylactic agents for ketosis (propionates and 1,2-propanedioli or propylenglykol) are metabolized via pyruvat to oxaloacetat.

The corresponding antiketogenic and other possible metabolical effects of a sugar mixture was studied in dairy cows. The experiment belonged to a research project studying the use of sugar alcohols, a byproduct of the industrial production of xylitol from birch trees, in the nutrition of domestic animals.

Experimental procedures

In the milk production trial were 19 Ayrshire and 5 Friesien cows, which were taken for trial in four groups or blocks weekly intervals. The time interval from parturition to the commencement of the trial was 24,5 d (-1—37 d). This parturition was the first for 11 of the cows and from the second to the sixth for the rest. For the first two weeks all cows had the same feeding regimen consisting of 2 kg hay, grass ensilage ad lib., and a grain concentrate mixture according to milk production as follows:

under	22,5 kg/d	7	kg	concentrate	mixture
22,5—25	»	7,5	»	»	»
over	25 »	8,0	»	»	»

At the end of this standardization period the cows were divided into 3 groups according to their fat corrected milk yields, days after calving and liveweights. The groups were fed different grain concentrate mixture (Table 1):

Group 1: 25 % dried beet pulp treated with a mixture of sugar alcohols
Group 2: 29 % dried molasses beet pulp;
Group 3: only grain and minerals

Table 1. Composition of concentrate mixtures.

Ingredients	Standardization period	Comparison period		
		Polyol group	Molasses group	Control group
Oat-barley mixture (1: 1)	76,3	71,3	67,3	96,1
Dried molasses beet pulp with 5 % urea	20,0		—	
Dried polyol beet pulp	—	25,0	—	
Dried molasses beet pulp	—		29,0	
Mineral mixture[1])	3,7	3,7	3,7	3,9[2])

[1]) In mineral mixture (g/kg): Ca 206,7, P 70,9, Mg 19,6, Na 59,7, Fe 3,65, Cu 0,42, Mn 0,45, Zn 2,12.

[2]) 3,7 % mineral mixture + 0,2 % ground limestone.

The polyol treated beet pulp was prepared by mixing a liquid mixture of sugar alcohols (the composition of polyols given in Table 2) into beet pulp and drying it. The sugar alcohol was manufactured by Sokerikemia Oy, Kotka and the beet pulps by Oy Juurikassokeri, Naantali.

Table 2. Composition of sugar alcohols in dried polyol beet pulp.

	%
Arabinitol	11,3
Xylitol	27,0
Galactitol	3,2
Mannitol	10,0
Sorbitol	8,0
Rhamnitol	4,0
Reducing sugars and other sugar alcohols (short chain)	36,5

The quantities of experimental concentrate mixtures were corrected according to feed unit concentration so that each group was offered the same amount of energy calculated as feed units, and the concentrate allowances were kept constant during the whole experiment.

The cows were fed individually twice a day at 05.00 and 14.00 hours. Refusals were collected after morning feeding. As well as once every second week the cows were weighed and also at the beginning and end of the standardization period and at the end of the experiment on two successive days after morning feeding.

Sampling and analyse

Milk produced was weighed at every milking. Once a week a sample was taken of the day's milk. Fat, protein and lactose contents of the samples were determined with an IRMA-analyser in Valio company's laboratory.

Aliquots of feeds (excepting ensilage) were taken daily and bulked into fortnightly samples. An ensilage sample was taken on the first day of each fortnightly period. DM contents were determined in an oven at +103—105° C, and samples for feed analyses were dried in a vacuum oven at +50° C. The DM content of the silage was corrected according to the volatile fatty acids content, adding 80 % of acetic acid and total amounts of propionic and butyric acids (JARL 1947, NORDFELDT 1955).

The food analyses were made on the dried samples by standard procedures (PALOHEIMO 1969) and sugars were determined according to SOMOGYI (1945), modified by SALO (1965). The quantity of polyols in polyol beet pulp was determined by periodic acid titration (TEGGE and BERGTHALLER 1970) and the composition of the polyols with a Carlo Erba gaschromatographer in the laboratory of the Finnish Sugar Co.

The volatile fatty acids in ensilage samples were determined with a Perkin Elmer F 11 gaschromatographer (HUIDA 1973) from waterextract, lactic acid (BARKER and SUMMERSON 1941) and ammonium-N with a Beckmann B spectrofotometer. Soluble N was determined by the Kjelldahl method.

Blood samples were taken every second week, from the jugular vein, 3 ½ hours after the beginning of morning feeding. Ketone bodies were determined by a microdiffusion method (STEGER and VOIGT 1970). Haemoglobin and packed cell volume were determined from whole blood. Glucose was determined by the o-toluidin-method (HULTMANN 1959, modified by HYVÄRINEN and NIKKILÄ

Table 3. Composition of feeds and feed values.

	DM %	In DM %						Sugars, g/kg DM	Polyols, g/kg DM	f.f.u. g/kg[1] DM	DCP g/kg DM
		Ash	Urea	Crude protein	Ether extract	Crude fibre	N F E				
Hay	80,6	6,8		10,3	1,7	34,3	46,9	69		0,514	57
Ensilage	26,7	8,6		19,8	6,7	25,4	39,5	15		0,731	136
Concentrate mixtures:											
Standardization	89,0	7,1	1,1	16,1[2])	3,0	8,8	67,1	67		1,009	119
Polyol beet pulp	88,1	6,0		11,9	3,0	8,8	70,3	43	75	1,019	88
Molasses beet pulp	88,0	8,3		13,4	2,5	9,5	66,3	93		0,986	97
Control	88,1	6,3		13,5	3,6	7,2	69,4	33		1,047	103

[1]) 1 f.f.u. (fattening feed unit) = 0,7 starch unit

[2]) with urea, without urea 12,9 %

1962), total protein by the biuret method (REINHOLD 1953), urea-N (CHANEY and MARBACH 1962) and uric acid (CARAWAY and HALD 1963) were determined from the plasma.

Towards the end of the comparison period 12 cows were also in a digestibility trial (collecting method). The urine was collected with the use of a rubber urinal. The collecting period was 7 days and at the end of that a rumen liquid sample was taken by rumen tube 3 ½ hours after morning feeding.

Calculation and statistical procedures

The weekly data of feed and nutrient consumption and milk yield were calculated for each cow. Feed unit consumption per kg FCM was calculated by using the maintenance requirement for energy, 4 f.f.u. per 500 kg liveweight, and for protein, 75 g DCP per maintenance f.f.u. (BREIREM 1969). The energy requirement for liveweight change was taken as 2 f.f.u./kg liveweight change. The effect of time is excluded in the calculating of correlations. For each cow average yield and nutrient consumption data for both the standardization and the comparison period was calculated. Yield data was tested by 2-way covariance analysis, where the factors were treatments and blocks and the regression variable was the yield of the standardization period.

Nutrient consumption was tested by 2-way variance analysis and the differences between treatment means by the Tukey-test (STEEL and TORRIE 1960).

Results from the milk production trial

The ensilage was of good quality; pH average 3,9 (3,6—4,3) and the butyric acid content 0,01 % in DM. The proportion of ammonium-N of the total-N was 4,2 % (1,9—5,7) and soluble-N of the total-N 59,4 % (44,7—65,2). The sugar content was low, 1,5 % in DM (0,9—3,0) and the contents of acetic and lactic acids were high, 2,4 and 9,1 % in DM.

Table 4. Feed consumption and liveweight change during the comparison period.

Diet		n	Intake of DM, kg/d Hay	Ensilage	Concentrate	Total	kg D M/ 100 kg liveweight	f.f.u./d	DCP g/d	Crude fibre kg/d	Sugars g/d	Polyols g/d	Liveweight change kg/d
Polyol beet pulp	$\bar{x}$	8	1,42	6,27[a]	6,45	14,14[a]	2,73[ab]	11,93[a]	1547[a]	2596[a]	463	483	−0,09[a]
	S.D.		0,21	1,55	0,32	1,60	0,33	1,22	225	391	25	25	0,36
Molasses beet pulp	$\bar{x}$	8	1,45	5,84[a]	5,75	13,04[a]	2,56[a]	10,70[a]	1474[a]	2479[a]	716		−0,31[a]
	S.D.		0,28	1,40	0,95	1,93	0,42	1,66	266	346	98		0,50
Control	$\bar{x}$	8	1,51	7,02[a]	6,34	14,88[a]	2,93[b]	12,57[a]	1747[a]	2704[a]	418		−0,01[a]
	S.D.		0,13	1,41	0,56	1,90	0,26	1,54	267	386	42		0,22

[a, b] (PLO, 05)

Sugar contents for concentrate mixtures of polyol beet pulp and control groups were low, 3,3 and 4,3 % on a dry basis. The concentrate mixture for the molasses beet pulp group contained 9,3 % sugars in DM. The concentrate mixture of the polyol beet pulp group contained 7,5 % polyols in DM. Intake of sugars from molasses beet pulp was 410 g/d in the molasses group and intake of polyols in the polyol group was 483 g/d.

Most cows ate the whole concentrate portion except some in molasses beet pulp group, where the consumption of concentrate from the offered amount was only 87 % (both other groups 99 %), during the comparison period. The intake of ensilage was lower in the molasses beet pulp group also. DM intake per 100 kg liveweight for the molasses group was 2,56 and for the control group 2,93 kg/d ($P < 0,05$). For the polyol group dry matter intake was 2,73 kg/100 kg liveweight (Table 4).

The fat corrected milk yield was similar in both the polyol and control groups (Fig.1). In contrast the yield of the molasses group was significantly

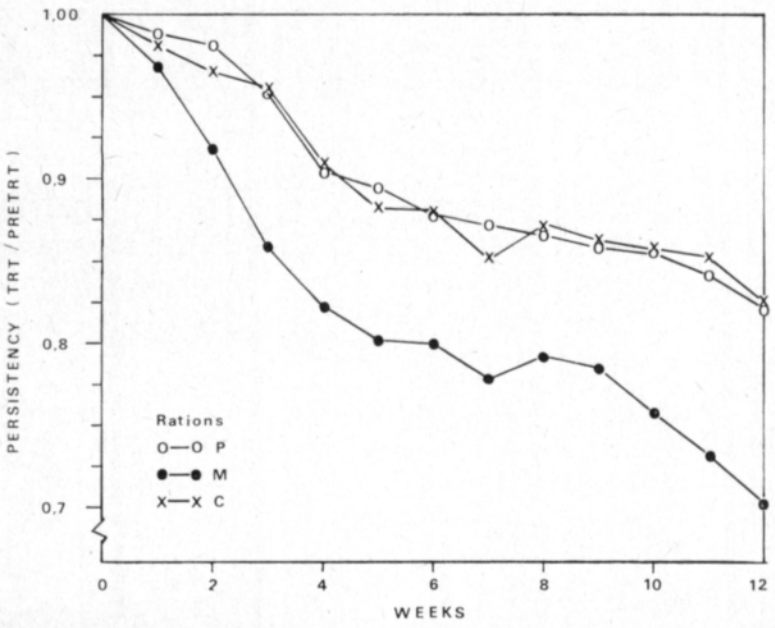

Figure 1. Persistency of FCM-yield of cows fed different carbohydrate supplements. P = polyol beet pulp group, M = molasses beet pulp group, C = control group.

Table 5. Yields data during the experiment and feed utilization during the comparison period.

Diet	n	Milk yield, kg/d		Milk fat, %		FCM (4 %), kg/d		Fat yield, g/d		Protein yield, g/d		Fat + protein + lactose yield, g/d		f.f.u./ kg FCM[1])	gDCP /kg FCM[1])
		Stand. period	Comparison period	Stand. period	Comparison period	Stand. period	Comparison period	Stand. period	Comparison period	Stand. period	Comparison period	Stand. period	Comparison period		
Polyol beet pulp	$\bar{x}$	8 20,63	19,03^{ab}	5,06	4,79^{a}	23,85	21,22^{a}	1040	907^{a}	676	633^{ab}	2737	2472^{ab}	0,375^{a}	58,4
	S.D.	2,19	2,10	0,73	0,61	3,39	2,67	188	139	126	72	352	279	0,038	7,4
Molasses beet pulp	$\bar{x}$	8 21,23	18,13^{a}	5,00	4,50^{a}	24,40	19,46^{b}	1060	814^{b}	680	587^{a}	2779	2272^{ac}	0,373^{a}	59,8
	S.D.	4,21	3,04	0,51	0,34	4,30	2,68	187	103	133	96	518	346	0,022	10,5
Control	$\bar{x}$	8 21,75	20,44^{b}	4,66	4,26^{a}	23,84	21,22^{a}	1010	869^{a}	690	660^{b}	2781	2527^{bd}	0,407^{b}	68,5
	S.D.	3,76	3,79	0,33	0,45	4,14	3,81	182	167	133	105	483	430	0,028	5,3

[1]) Requirement for maintenance and liveweight change deducted.
$^{a, b}$ ($P < 0,05$), $^{c, d}$ ($P < 0,01$)

Table 6. Blood values during the experiment.[1])

Diet		Haemoglobin g/100 ml		PCV, %		Ketone bodies, mg/100 ml		In plasma: Glucose, mg/100 ml		Total protein, g/100 ml		Urea-N, mg/100 ml		Uric acid, mg/100 ml	
		Stand. period	Comparison period	Stand. period	Comparison period	Stand. period	Comparison period	Stand. period	Comparison period	Stand. period	Comparison period	Stand. period	Comparison period	Stand. period	Comparison period
Polyol beet pulp	$\bar{x}$	12,4	11,8	34,3	31,5	4,24	6,43	60,4	55,8	7,96	7,71	14,4	13,2^{ac}	0,63	0,59
	S.D.	1,31	1,23	2,33	3,14	1,71	2,14	8,19	7,85	0,65	0,74	3,58	3,54	0,16	0,27
Molasses beet pulp	$\bar{x}$	11,9	11,5	33,3	31,0	8,50	5,70	52,2	55,9	7,62	7,63	12,3	12,7^{ac}	0,59	0,56
	S.D.	1,69	1,35	3,09	3,17	5,09	2,35	9,56	7,32	0,81	0,50	2,86	2,68	0,11	0,17
Control	$\bar{x}$	11,7	11,2	32,4	29,8	9,04	5,61	52,7	57,5	7,90	7,69	14,0	14,9^{d}	0,61	0,56
	S.D.	0,87	0,95	3,52	2,65	6,32	1,96	8,95	7,32	0,74	0,60	1,66	2,55	;0,09	0,17

[1]) On the standardization period 8 samples/group and on the comparison period 48, except uric acid 24, samples/group. $^{a, b}$ ($P < 0,05$), $^{c, d}$ ($P < 0,01$).

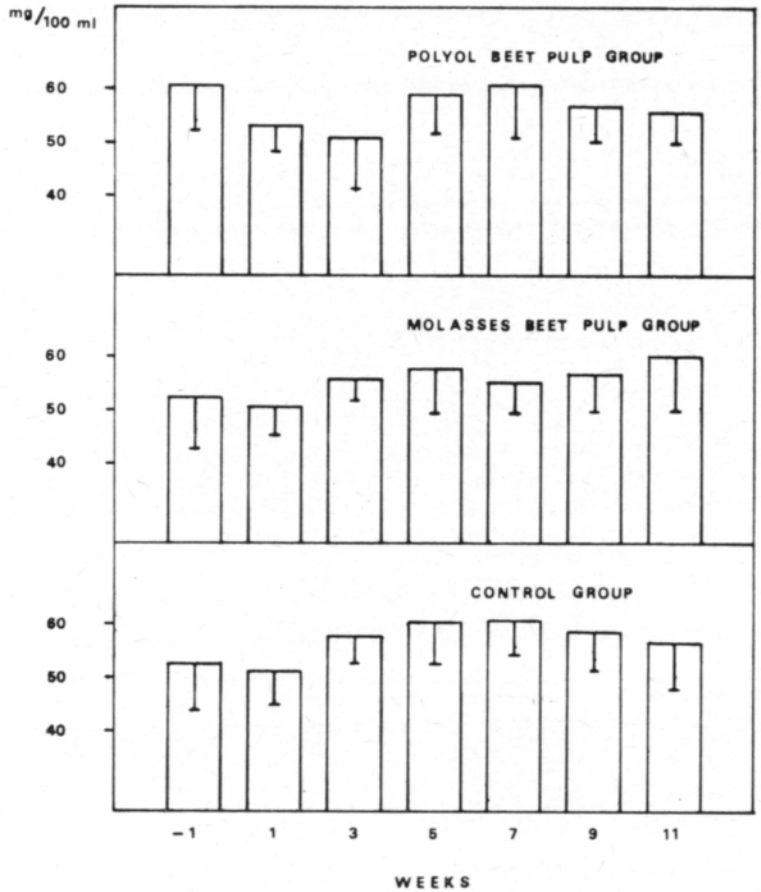

Figure 2. Plasma glucose concentration during standardization period (week −1) and feeding of experimental diets. Each group had eight cows. The data are expressed as mean and S.D.

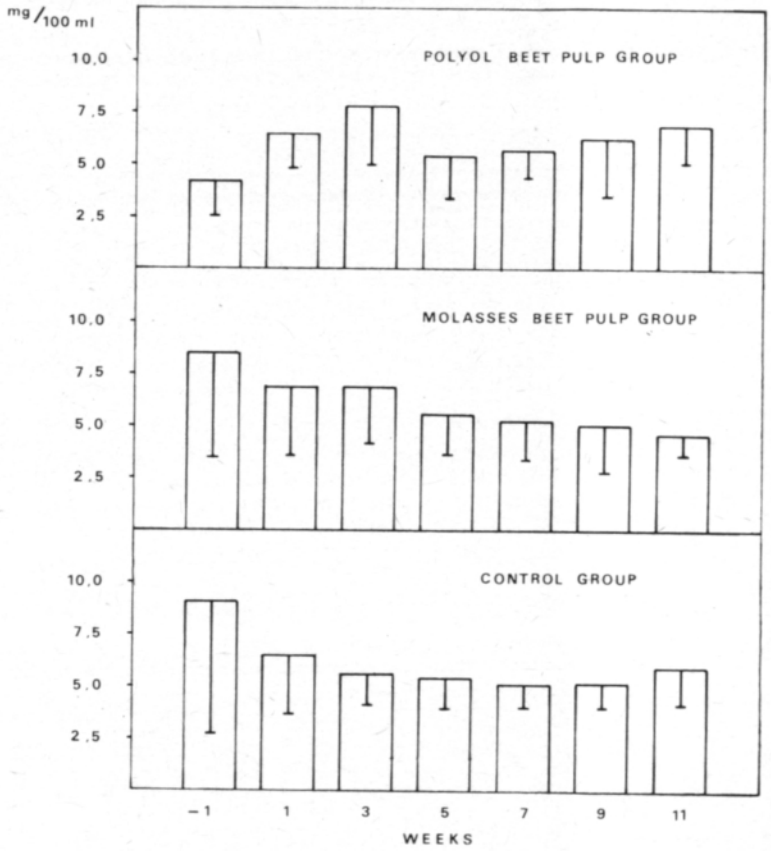

Figure 3. Plasma ketone bodies concentration during standardization period (week −1) and feeding of experimental diets.

lower ($P < 0,05$). Corresponding differences were also found in the fat, protein, and fat + protein + lactose yield (Table 5). Feed utilization was significantly better ($P < 0,05$) in the polyol and molasses groups than in the control group.

Blood ketone bodies and plasma glucose concentrations were at the same level in all groups (Table 6, Fig. 2 and 3). When the cows in all groups were divided into upper and lower groups based on yield (FCM), milk yield (kg/d), glucose and ketone bodies concentration (mg/100 ml) were in the upper half: 23,3, 56,8, and 6,58 for the polyol group, 21,5, 54,5 and 6,74 for the molasses group and 24,4, 55,7 and 6,59 for the control group. In the lower half the corresponding values were 19,1, 54,9, and 6,28 for the polyol group, 17,4, 57,4 and 4,64 for molasses group, and 18,0, 59,2, and 4,62 for the control group.

Correlation coefficients between the milk yield and blood ketone bodies concentration were 0,457 in the control group and 0,452 in the molasses group (both significant, $P < 0,001$, $n = 48$). In the polyol group the correlation was 0,141. Correlation between the milk yield and plasma glucose concentration was −0,399, −0,418 and −0,056. Correlations between blood glucose and plasma ketone bodies concentrations were −0,271 in polyol, −0,155 in molasses and −0,213 in control groups.

Plasma urea-N (Fig. 4) was significantly lower in the polyol and molasses groups than in the control group $P < 0,01$). In haemoglobin, packed cell volume, plasma total protein and uric acid there were no statistically significant differences.

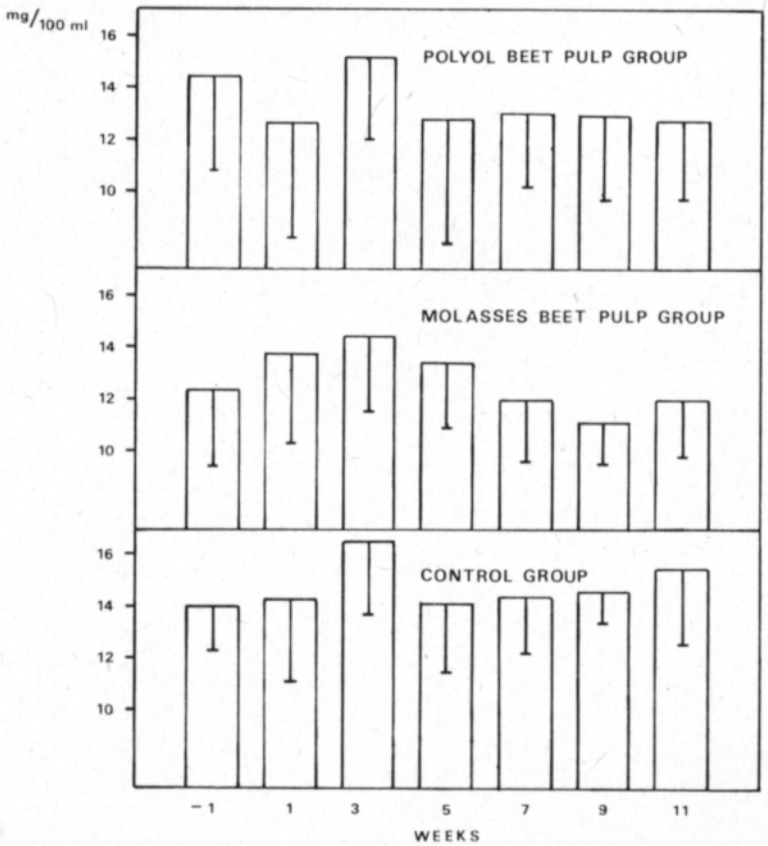

Figure 4. Plasma urea-N concentration during standardization period (week −1) and feeding of experimental diets.

Table 7. Intake and digestibility of nutrients in the digestibility trial on the cows.

Diet	Organic matter		Crude protein		Ether extract		Crude fibre		N.F.E.	
	$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.
Intake of nutrients, kg/d:										
Polyol beet pulp	13,05	1,26	2,24	0,30	0,66	0,10	2,53	0,36	7,62	0,53
Molasses beet pulp ...	12,85	1,97	2,38	0,40	0,62	0,09	2,68	0,33	7,18	1,19
Control	13,34	1,89	2,43	0,38	0,71	0,19	2,60	0,50	7,61	0,83
Digestibility of nutrients, %										
Polyol beet pulp	76,2	1,82	72,0	1,84	78,1^{ab}	2,68	63,7	3,55	81,4^{a}	1,51
Molasses beet pulp ...	74,3	1,40	72,5	1,48	75,1^{a}	1,24	62,3	5,20	78,5^{ab}	1,74
Control	73,6	1,10	73,5	2,06	79,3^{b}	1,89	58,7	3,69	78,1^{b}	1,32

^{a,b} ($P < 0,05$)

Results from the digestibility trial

The digestibility of nitrogen free extracts (Table 7) was higher in the polyol group than in the control group ($P < 0,05$). In the control group the digestibility of ether extract (crude fat) was higher than in the molasses group ($P < 0,05$).

In the control groups the bigger part of crude fat had its origin in the concentrate mixture (34 %) than in the molasses group (26 %), influencing the difference in digestibility of the ether extracts.

The proportion of butyric acid increased and that of acetic acid decreased in the polyol group (Table 8). Differences were almost but not statistically significant. The proportion of propionic acid was on the same level in all groups.

Table 8. Composition of VFA in the rumen liquid of cows in the digestibility trial (mol %).

Diet	n	Acetic acid		Propionic acid		Butyric acid	
		$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.
Polyol beet pulp	4	65,4	3,04	18,2	1,94	16,4	1,54
Molasses beet pulp ...	4	68,4	3,67	18,4	2,21	13,1	1,59
Control	4	67,7	2,75	18,5	1,06	13,8	2,04

Discussion

The much reduced feed intake of the molasses group is difficult to explain, although one cow suffered from ovarian cysts, leading to reduced feed intake and a liveweight loss of 107 kg during 12 weeks. Total DM intake and FCM-yield in the comparison period were in the molasses group, excluding that cow, 13,64 and 19,87 kg/d. In the standardization period the DM intake was in the polyol group 13,25, molasses group 13,43 and control group 13,30 kg/d·

The experiment was made using molasses beet pulp which was pelleted (Ø 11 mm) and ground in a hammermill before making the concentrate mixtures.

When feeding an ensilage based diet SALO et al. (1973) noticed a slightly lower DM intake and higher milk yield in a group fed with 31 % molasses beet pulp in their concentrate as compared to those in the control group. On the ad lib. ensilage feeding an extra molasses beet pulp allowance increased the DM intake 0,5 kg/kg beet pulp (CASTLE et al. 1966).

Supplementing the grain concentrate with 20 % molasses beet pulp had no effect on the total DM intake when ensilage was provided ad lib., and a concentrate mixture according to milk yield (SEPPÄLÄ and POUTIAINEN 1977).

The increase of feed utilization in the polyol and molasses groups was higher than the increase of digestibility of organic matter when compared with the control group. In the molasses group the DM intake in the milk production trial was 6,7 % lower than in the digestibility trial, which was possibly an influence on the higher increase of feed utilization in the production trial than was expected when considering the increased digestibilities in the digestibility trial. Where the molasses beet pulp supplementation has increased the dry matter intake, the feed utilization has not increased (CASTLE et al. 1966, HIRONAKA 1971).

DM intake in the polyol group was similar in the production and digestibility trials. The higher feed utilization of the polyol diet in the production trial could be contributed in part to the absorption of polyols in the rumen. Most of the propylenglykol is absorbed in the rumen (EMERY et al. 1967, CLAPPERTON and CZERCAWSKI 1972, VOIGT and PIATKOWSKI 1973) and supplementation of it in the concentrate mixture increased the utilization of metabolic energy when feeding the concentrate at high levels (1 kg/3 kg milk) (FISHER et al. 1973).

The lower plasma urea-N, in the polyol and molasses groups are the consequences of the lower protein intake there than in the control group (PRESTON 1965). Also DCP utilization for milk production was higher in these groups than the control group.

Clinical ketosis was not found during the experiment. In seven samples the level of ketone bodies rose over 10 mg/100 ml. Of these 3 were in the polyol group, 2 in the molasses and 2 in control group. The highest concentration of ketone bodies was 14,2 mg/100 ml in the comparison period.

The highly significant positive correlation between milk yield and ketone bodies in the molasses and control groups is partly due to a greater number of the lower yielding cows with lower ketone bodies content in these groups than in the polyol group.

Other results from the correlation between milk yield and blood ketone bodies are variable. EMERY (1964) found it positive ($r = +0{,}29$) on 15 cows, SCHWALM and SCHULTZ (1976) found no correlation on normal or ketotic cows, and, VIK-MO (1977), who took samples before morning milking, a highly significant negative correlation ($r = -0{,}35$) between milk yield and acetoacetate level. Correlation between blood glucose and ketone bodies is usually highly negative (SCHWALM and SCHULTZ 1977, ERFLE et al. 1973, HOVE 1974, RADLOFF et al. 1966).

The polyol group received xylitol and sorbitol, the only polyols shown to effect antiketogenic activity in the liver, at 169 g/d, but a part of these polyols are probably fermented in the rumen. Higher butyric acid formation has also diminished the possible antiketogenic effect of polyols. Galactitol and mannitol form most butyric acid in vitro (POUTIAINEN et al. 1976).

In this experiment there were also many young cows — when the ketose frequency is lowest. In Norway the frequency of first calvers treated (of all requiring veterinary treatment) was 6,1 %, and of second calvers 11,5 % (ANON. 1977).

The concentrate mixture allowances were also relatively high the average being 1 kg/2,9 kg FCM. SAUER et al. (1973) didn't find any emphatic effect with propylenglykol supplementation on the blood glucose and ketone bodies level when the cows had 1 kg concentrate/3 kg milk. However with restricted concentrate feeding the effect of propylenglykol on the blood values was marked.

Obviously it seems that polyols are utilized at least as effectively as molasses in the dried beet pulp, and that treated pulps increase feed utilization on a grain-ensilage based diet. The effect of the polyol mixture on the ketose status was not noticeable, but further investigations with more ketosis prone cows are needed.

Acknowledgments. The authors wish to express their great appreciation to Barbro Sumelius, Lena Hagert and Raili Piira for the care of experimental animals and feed and blood analyses. Financial support by Farmos Co and Finnish Sugar Co is gratefully acknowledged as well as the analyses of milk samples by the Valio company's laboratory.

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Ms received December 10, 1977

SELOSTUS

Sokerialkoholiseoksella käsitelty tai melassoitu juurikasleike lypsylehmillä säilörehuruokinnalla.

I. Vaikutus rehun hyväksikäyttöön, tuotokseen ja eräisiin veriarvoihin.

Mikko Tuori ja Esko Poutiainen
Helsingin yliopiston kotieläintieteen laitos, 00710 Helsinki 71

Lypsylehmillä suoritetussa ruokintakokeessa tutkittiin ksylitolin valmistuksessa syntyvää sivutuotetta, sokerialkoholiseosta, sisältävän tai melassoidun juurikasleikkeen vaikutusta rehunkulutukseen, maitotuotokseen, rehun hyväksikäyttöön ja eräisiin veriarvoihin.

Kokeessa oli 24 lehmää jaettu kolmeen ruokintaryhmään. Polyoli- eli sokerialkoholiryhmän väkirehuseoksessa oli 25 % polyolileikettä, melassileikeryhmän seoksessa 29 % melassileikettä ja vertailuryhmän seoksessa oli pelkästään viljaseosta ja kivennäistä. Lehmät saivat heinää 2 kg/d, säilörehua ad lib. ja väkirehua 7—8 kg lähtötuotoksen mukaan läpi koko kokeen ajan. Vertailukauden pituus oli 12 viikkoa, jota edelsi 2 viikon vakiointikausi.

Melassileikeryhmällä rehunkulutus oli merkitsevästi ($P < 0,05$) alempi kuin vertailuryhmällä (2,56 ja 2,93 kg ka/100 elopainokg). Polyolileikeryhmällä se oli vastaavasti 2,73. Leikkeestä eläimet saivat keskimäärin 483 g polyoleja/d polyolileikeryhmässä tai sokereja

410 g/d melassileikeryhmässä. Alentuneesta rehunkulutuksesta johtuen maitotuotos oli merkitsevästi ($P < 0,05$) alempi melassileikeryhmällä kuin polyolileike- tai vertailuryhmillä (19,5, 21,2 ja 21,2 kg 4 %:ista maitoa/d). Rehun hyväksikäyttö jäi kuitenkin vertailuryhmällä merkitsevästi ($P < 0,05$) huonommaksi kuin polyolileike- tai melassileikeryhmillä (0,407, 0,375, ja 0,373 ry/kg 4-%:ista maitoa).

Suoritetussa sulavuuskokeessa 12 lehmällä typettömien uuteaineiden sulavuus oli polyolileikeryhmällä merkitsevästi ($P < 0,05$) korkeampi kuin vertailuryhmällä (81,4 ja 78,1 %). Melassileikeryhmällävastaava sulavuus oli 78,5 %. Erot orgaanisen aineen sulavuuksissa olivat samansuuntaisia, mutta eivät merkitseviä.

Mahaletkulla otetuissa pötsinestenäytteissä havaittiin polyolileikeryhmällä selvästi korkein voihappopitoisuus, vaikkakaan erot muihin ryhmiin eivät olleet merkitseviä.

Verinäytteistä määritettiin veren hemoglobiini, hematokriitti ja ketoaineet sekä plasmasta glukoosi, kokonaisvalkuainen, urea-N ja virtsahappo. Plasman urea-N-pitoisuus oli vertailuryhmällä merkitsevästi korkeampi ($P < 0,05$) kuin polyoli- tai melassileikeryhmillä (14,9, 13,2 ja 12,7 mg/100 ml). Muissa veriarvoissa ei ollut eroa ruokintaryhmien välillä.