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From the Department of Animal Husbandry and Genetics, the Department of Internal Medicine I and the Department of Pathology, Veterinary College of Norway, Oslo.

INDIGESTION IN YOUNG CALVES

I. DIFFERENT LACTOSE LEVELS IN MILK DIETS AND MILK REPLACERS

By

P. Slagsvold, B. Laksesvela, K. Flatlandsmo, N. Krogh, T. L. Ulstein, N. Ek and *T. Landsverk*

SLAGSVOLD, P., B. LAKSESVELA, K. FLATLANDSMO, N. KROGH, T. L. ULSTEIN, N. EK and T. LANDSVERK: *Indigestion in young calves. I. Different lactose levels in milk diets and milk replacers.* Acta vet. scand. 1977, *18*, 194—209. — Increasing the lactose content of different milk replacers or milk diets by approx. 30 % of the dry matter increased the frequency of diarrhoea the first 10—12 days in young calves on all occasions in 5 experiments comprising 120 calves. For all diets taken together, this effect was highly significant. Total daily intakes of lactose amounted to 200—480 g. When lactose was given on top of the milk rations, the growth rate increased significantly, whereas the growth rate was usually insignificantly reduced when lactose replaced other nutrients in milk diets or milk replacers, their levels of protein and fat becoming low. Albumin and total protein in blood plasma were significantly lower when the dietary protein level was low. Milk replacers with 20 or 40 % whey powder, replacing skim milk powder, performed equally well, but gave significantly less growth than the old-fashioned feeding of whole milk-skim milk. Intake of hay and barley and a number of clinical and histological or pathological parameters did not vary consistently with dietary level of whey powder or lactose. Feeding whole milk all the time resulted in low intake of hay and barley and poorly developed forestomachs, but high dressing-out %. Substituting soya for part of the skim milk powder in milk replacers gave abomasal content with no curds. In most cases, pH in the rumen appeared to be nearly up to neutral until the calves ate ground barley, about 1 month old.

lactose levels; indigestion; calves.

According to recent *Veterinary Statistics* (1974), approx. 2.5 % of all calves in Norway suffer from neonatal diseases of some kind or other. No special statistics are made out for indigestion, but it is understood that this ailment increases. At the Department of Pathology, Veterinary College of Norway, almost

35 % of all cases examined in 1972—74 were diagnosed as indigestion, as compared to 20—25 % in 1970—71. Similar figures have been reported from Great Britain (*Withers* 1952, *Blaxter & Wood* 1953). *Hartman et al.* (1974) found in the USA that mortality amongst young calves increased with the size of the herds, from 15.8 % in herds under 100 to 27.2 % in herds over 200 animals.

Ill or dead calves examined here usually were 4—10 weeks old and had been fed milk replacers. Calves dying had in most cases been ill only for a few days. They showed diarrhoea, and in some cases evil-smelling stomach content was evacuated through the mouth. Necropsy showed catarrhal enteritis, cachexia and often ulcers in the rumen and abomasum. In a few cases, Salmonella or other specific pathogens were detected.

For some decades, calf rearing in Norway has been based on milk replacers. Earlier they consisted mainly of skim milk powder, but it has later been replaced to varying degrees by whey powder, soya protein or other materials. It was questioned whether high levels of whey powder, with its high content of lactose could reduce rumen pH since it has been shown that much barley could do so (*Fell et al.* 1968). Low pH has been found to be accompanied by a higher frequency of abomasal ulcers (*Hemmingsen* 1966). Abomasal ulcers and scars are, however, common in calves, *Groth & Berner* (1971) suggesting that 95 % of all calves may get such lesions. According to *Roy* (1970, 1974) excess lactose, passing into the intestine, may result in saccharolytic fermentation and formation of products irritating the intestine thus causing diarrhoea.

Feeding and environment were supposed to be among the major factors causing indigestion in young calves in Norway, since specific infections appear to be rare. This paper describes 5 experiments, numbered 2—6, concerning the relationship between the percentage of whey powder and lactose in milk replacers and indigestion.

MATERIALS AND METHODS

Diets and feeding

Altogether 11 dietary conditions (A-K) were tested, 6 (C-H) being milk diets or milk to which lactose was added, the other 5 (A and B and I-K) being milk replacers. Composition and nutrient content of the diets are listed in Table 1.

Table 1. Composition and nutrient content of the diets, all in percentages.

	Milk replacers[1]					Milk diets			
	A	B	I	J	K	C[2]	D & E	F & H	G
Whole milk (Wm)	—	—	—	—	—	Wm over to Sm	Wm over to Sm	Wm	Wm
Skim milk (Sm)	—	—	—	—	—			—	—
Lactose	—	—	30	—	28	—	5[3]	—	5[3]
Skim milk powder	59.7	39.7	41.4	29.7	26.7	—	—	—	—
Whey powder	20	40	14	—	—	—	—	—	—
Whey p. "delact".	—	—	—	20	—	—	—	—	—
Dextrose	—	—	—	8	—	—	—	—	—
Soya prot.	—	—	—	22	25	—	—	—	—
Butter	19	19	13.3	19	19	—	—	—	—
Nutr. content, % of dry matter									
Lactose	48.1	52.7	63.6	26.0	44.3	36.6—52.6	54.4—69.2	36.6	54.4
Protein	24.3	19.6	17.0	31.2	26.8	26.5—38.1	19.1—24.7	26.5	19.1
Fat	20.5	25.5	14.4	21.1	20.8	31.2— 0.7	22.4— 0.4	31.2	22.4

[1] The milk replacers were supplemented with 0.8 % refined lecithin and synthetic monoglyceride in a ratio of 82:18, and also a pre-mix supplying the following per kg air dry powder: $CaHPO_4$ 3000, $MgCO_3$ 1700, $CaCO_3$ 158, $MnSO_4$ 105, $MgCO_3$ 22.5, $ZnSO_4$ 9, $CoSO_4$ 3.8, KJ 1.5, all in mg, and Vit. A 20,000, Vit. D 3,000, Vit. E 30, all in i.u.

[2] See footnote to Table 2.

[3] In percentage of the weight of the milk.

The milk diet C represented the old-fashioned feeding of whole milk only during the first weeks, gradually changing over to skim milk only. Exactly how this was done is shown for diet C in a footnote to Table 2, listing daily allowances of milk or milk replacers and of ground barley. Diet D furnished the same quantities of whole milk and skim milk as diet C and 50 g lactose per l in addition. Diet E was composed like D, but administered in reduced quantities, so that E and C became isocaloric throughout the test. The whole milk diet H was administered in quantities so as to become isocaloric to G, which conveyed the same quantities of whole milk as F, plus 50 g lactose per l. Which diets were compared to each other is visible from Tables 3—5, stating the results.

Table 2. Daily allowances of milk[1] or milk replacers and ground barley.

Week on exp.	Milk or milk replacers, l Diets A, B, C, I, J and K	Whole milk, l F	H	Barley
1—2	4.5	4.5	5.6	—
2—3	5.0	5.0	6.25	—
3—4	5.5	5.5	6.9	Ad lib.
4—5	6.0	6.0	7.5	Ad lib.
5—6	6.5	6.0	7.5	300 g
6—7	7.0	6.0	7.5	700 g
7—9	7.0			700 g

[1] Diet C consisted of whole milk only for the first 2 weeks, in the 3rd week the 5.5 l were made up of 1.25—2.5 l sk.m., in the 4th week the 6 l were made up of 3—4.25 l sk.m. which thereafter made up all.

The milk replacers were mixed mechanically with tepid water to a dry matter content of 10.3 % before the meals, at 7.30 a.m. and 2 p.m. The mixtures and milk were pail-fed, the quantities listed in Table 2 being averages for the respective regimens. The individual calf got its share according to metabolic weight.

After approx. 2 weeks on experiment, the calves received tepid water, grund barley and hay chopped to lengths of approx. 5 cm, all ad libitum, except that the barley was administered according to metabolic weight from the 4th week on experiment. In Exp. 6, 3 g NaCl, 4.3 g $NaHCO_3$ and 2 g KCl were added per l water.

Feed ingredients

Whey powder and skim milk powder were both low pressure, spray dried. They were analyzed for major nutrients, a number of macro- and microminerals and amino acids. As no values gave rise to questions connected with the problem concerned, they are not recorded here.

"Delactosed" whey powder contained 46 % lactose, 25 % protein, 1.5 % fat and 20 % ash. This and lactose were also spray dried. Soya protein was acid hydrolysed and contained 64 % protein, 0.3 % fat, 4.5 % ash and 2.5 % crude fibres.

Calves and housing

Calves fed colostrum and thereafter whole milk were obtained directly from a number of herds in the neighbourhood, usually 5—10, occasionally 3—16 days old. One or 2 days after arrival they were allotted as evenly as possible to identical groups according to age, live weight and sex, being housed in clean, well ventilated stables, electrically heated in the winter. Average age and weight were approx. 8 days and 40 kg at the start of the experiments. The number of calves and the duration of the test are set out in Table 3.

Clinical and biochemical examinations

The calves were inspected at least twice a day and usually weighed and examined clinically once a week. The consistence of the faeces was graded according to a scale 1—5, the lowest meaning very solid and the highest profuse diarrhoea.

Rumen contents were sampled regularly 2—3 hrs. after the morning meal and examined macro- and microscopically. The pH was measured potentiometrically.

Blood samples, drawn at approx. 9 a.m., were analyzed refractometrically for total protein according to *Dimopoullos* (1963), and for serum albumine and IgG by electrophoresis according to *Ek* (1969). Further, haemoglobin, haematocrit, free plasma amino acids and the enzymes GOT and GPT were assessed.

Post slaughter examinations of the digestive tract

Slaughtering took place at 11—11.30 a.m. in an abattoir, the forestomachs and abomasum being collected and examined macroscopically.

The compartments were weighed together and separately, and in the last 2 experiments they were also emptied and weighed. The contents were also weighed and examined, and the appearance of the rumen papilla and their height on the ventral floor of Atrium ruminis were recorded. Sections for histological examination were taken from the ventral part of Atrium ruminis, liver, kidney and M. ileopsoas, fixed in 10 % neutral buffered formalin, and stained with haemotoxylineosin. Sometimes sections were also taken from lesions and additional staining with Gram, Methylene blue and PAS (Periodic acid-Schiff method) was performed.

RESULTS

Weight gain, dressing-out %, feed intake and diarrhoea

Data on weight gain, dressing-out %, intake of hay and barley and frequency of diarrhoea are recorded in Table 3. The figures for the consumption of milk or milk replacers are not included. With a few exceptions the allowances of these feeds were consumed totally.

The growth rate was significantly greater on diet C than on A and B ($P < 0.001$), and significantly greater on diet D than on C and E ($P < 0.05$—0.01). Diets G and H sustained faster growth

Table 3. Weight gain, dressing-out %, intake of hay and barley and days with diarrhoea, averages per calf.

Exp. no.	Diet	Number of calves per group	Days on exp.	Wt. gain kg	Dress. %	Daily intake, g		Diarrhoea, days
						hay	barley	
2	A	8	61	33.9	51.9	236	383	1.7
	B	8	61	33.4	51.7	230	381	3.0
	C	8	61	49.3	52.0	328	443	3.5
3	C	8	42	22.3	51.5	48	142	2.6
	D	8	42	29.4	51.8	39	114	7.6
	E	8	42	19.8	50.6	45	115	4.4
4	F	8	42	20.5	56.1	45	79	1.4
	G	8	42	25.3	58.7	38	38	4.5
	H	8	42	27.2	56.5	33	65	2.2
5	A	6	42	19.7	51.3	89	159	0.7
	I	6	42	17.8	49.1	52	145	4.8
6	A	9	55	30.9	50.3	79	239	1.6
	I	9	55	26.5	51.2	76	236	4.5
	J	9	55	27.9	50.2	54	213	2.6
	K	9	55	24.4	50.0	69	195	5.0

than F ($P < 0.05$—0.02), whereas diet I gave significantly less growth than A in Exp. 6 ($P < 0.05$). Other differences did not reach significance.

The dressing-out %'es were significantly higher on diets F, G and H than on the other diets ($P < 0.01$). For the rest, there were no marked differences.

Intake of hay and barley was greatest in Exp. 2, which lasted nearly 9 weeks. It was particularly low on diets with whole milk.

Diarrhoea, occurring mainly the first 10—12 days on experiment, was significantly more frequent when lactose was added ($P < 0.001$). Nearly all calves fed lactose had more or less diarrhoea, whilst many fed the other diets escaped it. Strangely, most calves having diarrhoea grew as fast as those without.

Clinical findings

Of a total of 120 calves 3 died, all belonging to Exp. 3. One was fed diet D and the 2 others diet E. They were only 3 days old when put on experimental diets, developing profuse diarrhoea and dying suddenly after approx. 1 week. In Exp. 2, 3 calves developed severe rumen putrefaction, 1 being fed diet A becoming moribund was killed, while another on the same diet recovered spontaneously. The third one, fed diet B, recovered after having had its rumen emptied and "washed", thereafter given rumen contents from a ruminating cow and fed hay and barley. Another calf fed diet B contracted pneumonia, but recovered.

Some hairloss was quite common among all the calves. Hairloss around the muzzle, however, was most frequently seen in calves fed milk replacers.

Table 4 presents some results of the examination of rumen content.

Determination of the rumen pH revealed extensive variation (4.5—8.1). This variation was seen when comparing individuals within each group at the same sampling and when comparing weekly samples from the same individual. The majority of pH values (about 70 %) lay within the interval 6.0—7.0.

The macroscopic appearance of the rumen content varied considerably. The odour varied from aromatic to strongly acidic or almost faecal. Many samples contained milk and/or milk clots. Hairs and litter particles were often plentiful before the calves started eating hay and barley.

Direct microscopy revealed great variation in the rumen flora.

Table 4. Examination of rumen content.

Exp.	2			3			4			6				Total
Diet	A	B	C	C	D	E	F	G	H	A	I	J	K	(Samples)
Number of samples														
Total	75[1]	75[1]	70[1]	8[2]	8[2]	8[2]	10[2]	10[2]	10[2]	21[3]	21[3]	21[3]	21[3]	358
Macro- and microscopically "abnormal"	12	8	1	1	2	1	0	0	3	0	0	9	1	38
With pH below 6	14	10	2	2	0	3	2	3	6	7	10	14	12	85
With pH above 7.2	6	4	7	0	0	0	0	0	0	0	0	1	0	18
With motile flagellates														
many	7	7	7	1	1	2	1	1	0	7	5	2	4	45
few	11	20	13	1	0	0	3	1	1	6	5	1	3	65
With ciliates	0	4	0	0	0	0	0	0	0	0	0	0	0	4

[1] Weekly samples from all 8 calves in the groups.
[2] Weekly samples from 2 calves per group the last 4 weeks.
[3] Weekly samples from 3 calves per group.

Flagellates often occurred, sometimes in abundance, but were seldom seen when pH of the contents fell below 6.

Ciliates were only found in Exp. 2 during the last 2 weeks and then only in 2 calves that had been stabled closest to adult animals.

Biochemical findings

In all groups there was a decrease in the level of total serum protein during the first half of the experiment. From the middle of the experimental period, however, the level increased to about the starting point, except for calves fed diet I with a high lactose and low protein concentration. In these groups the total protein decreased steadily during the experiment. The same groups showed a corresponding fall in the albumin content, whereas in the other groups the albumin level kept fairly constant. In Exp. 6 the difference between calves fed diet A and I was significant ($P < 0.05$). No obvious relationship was found between the blood haemoglobin, haematocrit, GOT, GPT, LHD or free amino acids and the various diets.

Post slaughter findings in the digestive tract

Data from the post slaughter examinations of the digestive tract are recorded in Table 5.

Weight of the rumen with content was apparently less when lactose was added, but the tendency became almost absent when the content was removed. The rumen was always filled with roughage of varying consistence. Curds or other abnormalities were absent in it. For abomasum, there was no tendency that its size varied with the diets. Abomasal content consisted of curds of 1—3 cm in diameter, but calves fed diets J and K had no curds.

Macroscopic examination. Some of the calves showed thickened papillae which were fused together to form conspicuous ridges. In these calves the stomach wall felt stiff and hardened. The pathological changes were more pronounced in the ventral and caudal rumen sacs than in the atrium, and even the laminae of the reticulum were thickened and hardened. The ulcers and scars of the rumen in the first 3 experiments were few and small; usually less than 2 cm in total length. The lesions in Exps. 5 and 6 were always more severe with total length mostly between 2.5 and 10 cm and often more than 10 cm. In all the experiments the

Table 5. Post slaughter examinations of the digestive tract.

	Exp.	2			3			4			5		6			
	Diet	A	B	C	C	D	E	F	G	H	A	I	A	I	J	K
Weight in kg																
Rumen retic. with cont.		7.8	7.1	8.3	5.1	4.6	5.0	2.7	2.1	2.7	4.8	4.2	4.7	4.4	4.5	4.3
„ „ without „											0.8	0.7	1.0	1.0	0.9	0.9
Abomasum with „		0.6	0.7	0.7	1.3	1.4	1.1	1.1	1.4	1.4	1.1	1.2	1.1	1.2	0.8	0.6
„ without „											0.4	0.3	0.4	0.4	0.3	0.3
Lesions in the forestomachs[1]																
Ulcers in the rumen		3/8	3/8	2/8	1/8	0/8	0/8	1/8	0/8	2/8	2/6	2/6	3/9	5/9	6/9	7/9
Scars „ „ „		5/8	3/8	6/8	2/8	4/8	2/8	1/8	1/8	5/8	2/6	1/6	3/9	2/9	2/9	4/9
Necrosis in the omasum		3/8	1/8	1/8	2/8	2/7	1/6	0/8	0/8	0/8	1/6	0/6	6/9	2/9	2/9	5/9
Ulcers in the abomasum		0/8	0/8	0/8	0/8	0/7	2/6	0/8	0/8	0/8	0/6	0/6	2/9	3/9	1/9	1/9
Rumen papilla development																
Length in mm of papilla in Atrium ruminis[2]		4.1	3.7	6.4	2.3	2.4	3.0	1.5	1.1	1.5	2.0	1.9	2.6	1.9	2.0	1.8
Hyperkeratosis in the rumen epithelium[1]		0/8	0/8	0/8	5/8	1/7	4/6	2/8	1/8	3/7	2/6	3/6	3/9	1/9	5/9	5/9

[1] Calves with lesions out of all calves in the group.
[2] When ridges were present they were measured from the bottom to the top.

lesions were situated at the anterior and posterior pillars and sometimes also at the right longitudinal pillars. The lesions in the first 3 experiments were relatively shallow, whereas the lesions in Exps. 5 and 6 were deeper with raised edges and hyperaemic ulcer surface. In 1 calf in each of the last 3 groups in Exp. 6 extensive necrosis of the anterior and posterior pillars developed. In the last 4 experiments 59 % of the calves with thickened and hyperkeratotic papilla showed ulcers and scars versus 48 % of the calves with normal epithelium. The lesions of the omasum appeared as necroses usually situated at the borders of the laminae, seldom more than 5 mm in length. Occasionally round spots of necroses in the middle of the laminae were found. Scars might appear as round empty holes in the laminae. The ulcers of the abomasum were shallow and never more than 8 mm in total length. They were usually situated in the pyloric region.

Microscopy. The findings of hyperkeratosis correlated well with thickened papillae in the Atrium ruminis. In Table 5 hyperkeratosis is used as a common denominator of these changes. The ridges appeared to be foldings of the mucosa with proliferating hyperkeratotic papillae extending like branches of a tree from the fibrous core of mucosa. Microabscesses in the epithelium were observed sporadically. Moderate aggregations of lymphocytes and eosinophils were often recorded, and seemed to occur without connection to other changes. Examination of the necrotic lesions in rumen and omasum never revealed any fungi or signs of necrobacillosis.

Bacteriological examinations of ruminal and abomasal necrosis did not demonstrate any fungi or Fusobacterium necrophorum.

DISCUSSION

Diets and nutrients

In order to find out whether or not the high lactose content of whey powder may cause indigestion it was found appropriate to use pure lactose and diets with more marked differences in lactose content than can be attained by varying the percentages of whey powder and skim milk powder in a diet. The whole milk-skim milk diet C served as a means of comparing the milk replacers to a regime which is supposed to cause a minimum of ailments. A change-over from whole milk to skim milk implies

great changes in nutrient supply (Table 2). This was overcome by the aid of the whole milk diets.

Lactose did not turn out to cause serious ailments, despite the testing of much higher percentages of lactose than fed in practice in this country, and comparing the high lactose diets to control diets rather low in lactose. Truly, we found that additions of 30 % lactose in % of the dry matter of the diets significantly increased the frequency of diarrhoea. (A total lactose content of 50 % and 5 l with 10.3 % dry matter gives approx. 250 g lactose a day). *Blaxter & Wood* (1953) found that 500 g lactose per calf per day caused diarrhoea and that 200 g lactose or glucose reduced the dry matter content of the faeces by 10—15 %. The lactose-induced diarrhoea did not seem to retard the growth of the calves. More surprising, *Volcani & Ben-Asher* (1974) obtained good results with sweet whey powder only to postcolostrum 4 days old calves.

Further, our results with diets D and G indicated that lactose was well utilized for growth. Less growth on diets E, G, I or K than on the respective controls could well be explained by deficiencies of protein and perhaps also fat. We do not think that any of our diets were deficient in minerals or vitamins, as these nutrients were either supplied or present in the milk products used in the diets in sufficient quantities. Butter was used as a fat source to avoid doubts about the composition of the fat.

The fact that the calves grew better on diet C than on A and B is thought to be due to the higher levels of both protein and fat in C as long as it consisted of whole milk. Being fed according to metabolic weight calves fed C were thus secured greater allowances of food also later on.

Clinical and biochemical findings

The 3 calves which died in Exp. 3, having received colostrum only 2 days, appeared to be too young to be put on experimental diets. In later experiments, the youngest calves were 4 days old when they were fed the experimental diets, and no more calves died. It is hardly correct to blame the composition of the milk replacers for these casualties.

It was tried to induce indigestion by the aid of whey powder and lactose, but no more than 3 calves died and 3—4 others turned ill out of a total of 120 i.e. a mortality of 2.5 % and mortality plus illness of 5—6 %. These figures are not high, despite

the fact that it was intended to expose the calves to dietary stress. Good housing conditions, hygiene and attendance are supposed to have strengthened the health.

At present, it does not seem possible to define any clear relationship between varying rumen content and the growth rate or state of health of the calves. *Roy* (1970) has suggested that the intestine bacterial flora is probably of greater importance for the development of diarrhoea than the rumen microbes.

Low levels of albumin and total protein in the blood plasma of calves fed diet I could be explained by protein deficiency (*Allison* 1957, *Weymer et al.* 1959 a, b).

Post slaughter findings

Weights of the rumen were all over a little low in comparison to those reported by *Godfrey* (1961) for grazing calves. Feeding whole milk all the time gave a very small rumen, calves on the respective regimens eating small rations of hay.

The lengths of the papillae did not differ much, uniformity in this respect being thought to be due to feeding hay to all calves.

The appearances of the papillae showed a surprising lack of uniformity, with great variations within the groups. The club-shaped papillae with hyperkeratosis resembled those described by *Fell et al.* (1968) and *Kay et al.* (1969) for calves on high barley diets. However, the papillae lacked trapped hairs.

Ulcers and scars occurred mainly on the rumen pillars. As lesions were also found in many rumens without hyperkeratosis, a different pathogenetic mechanism than that causing hyperkeratosis may be suspected.

The tendency of a higher incidence of ulcers and hyperkeratosis in the rumen of calves fed soya is not easy to explain. It can only be suggested that the abscence of curds in abomasum on diet J and K may have facilitated regurgitation into the rumen.

The experiments recorded here did not point out lactose as a factor responsible for lesions in the walls of the forestomachs. However, overflow of the reticular groove with degradation of milk or milk replacer in the rumen might account for some of the differences in rumen appearance. Pail feeding may lead to overflow of the reticular groove (*Wise & Anderson* 1939, *Hegland et al.* 1957). Individual differences in this respect might have a modifying influence.

CONCLUSION

Added lactose significantly increased the frequency of diarrhoea, but the calves grew normally. A number of clinical and pathological parameters did not differ consistently between diets to which lactose had been added or not.

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SAMMENDRAG

Indigestion hos unge kalver. I. Ulike mengder laktose i melkedietter og melkeerstatninger.

Tilsetning av laktose til ulike melkeerstatninger og melkedietter, svarende til ca. 30 % av tørrstoffinnholdet, økte diaréfrekvensen de første 10—12 dagene hos unge kalver i alle tilfeller i 5 forsøk som omfattet i alt 120 kalver. For alle dietter sett under ett, var forskjellen høyst signifikant. Totale mengder laktose pr. kalv pr. dag beløp seg til ca. 200—480 g.

Når laktose ble gitt i tillegg til faste rasjoner av melk, vokste kalvene statistisk sikkert bedre, mens veksten i de fleste tilfeller var noe, men ikke statistisk sikkert nedsatt, når laktose erstattet andre næringsstoffer i melkedietter eller melkeerstatninger og de fikk lavere prosentisk innhold av protein og fett. Også albumin og totalt protein i blodplasma gikk sikkert ned når diettene således fikk redusert innhold av protein.

Melkeerstatninger med 20 eller 40 % mysepulver i stedet for skummetmelkpulver ga like resultater, men statistisk sikkert mindre vekst enn „gammeldags" fôring med helmelk-skummetmelk.

Opptak av høy og byggrøpp og kliniske symptomer og patologiske funn viste ikke noen klar sammenheng med laktosetilsetning eller innhold av mysepulver i diettene.

Fôring med helmelk gjennom hele forsøkstiden var ledsaget av små opptak av høy og byggrøpp og lite utviklede formager, mens slakteprosenten ble høy.

Erstatning av en del skummetmelkpulver med soya ga løpeinnhold uten koagler. I de fleste tilfeller var pH i vomma nær nøytral inntil kalvene fikk byggrøpp, omlag månedsgamle.

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Reprints may be requested from: P. Slagsvold, Veterinary College of Norway, P. O. Box 8146, Oslo Dep., Oslo 1, Norway.