The use of treated rape cake in a calf starter diet

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ABSTRACT: The objective of the experiment was to evaluate the effect of starter diet containing 10% of treated rape cake (TRC) with a reduced glucosinolate content on calf growth, development and health. The experiment included 45 calves allocated into 3 groups. After the colostrum period (5 days) the calves were fed 4 l of pooled fresh milk per calf/day and one of the starters *ad libitum*. The control group (S) was fed Standard starter with components with a standard nutrient content including fibre. Comparative group T was fed Telstar starter, which contained whole maize kernels and protein pellets. Experimental group G was fed Grant starter containing 10% of treated rape cake. The calves were fed hay *ad libitum* from 10 weeks of age. The average starter consumption (calf/day) over a 90-day feeding period was 1.34, 1.72 and 1.45 kg of the Standard, Telstar and Grant diet, respectively. An insignificantly higher body weight of calves was recorded for the Grant group at the end of the experimental period. When the calculated indices were compared, it was obvious that the weight gains obtained with experimental starters Grant and comparative Telstar were by 4.0% higher and by 5.4% lower, respectively, than in the control group Standard. No significant changes in the parameters of nitrogen, energy, lipid and mineral metabolism, health status, hepatic parenchyma and thyroid function were observed throughout the experimental period. The diet based on experimental starter Grant had no adverse effect on the ruminal fermentation in calves. It may therefore be concluded that the starter diet with 10% content of treated rape cake had no adverse effect on calf growth and performance.

Keywords: *Brassica napus*; treated rape cake; nutrient consumption; weight gain; metabolic profile; rumen fluid

Rapeseed processing by the food and chemical industry involves some useful by-products which can be used as feeds, primarily as a protein component of the diet, as their amino acid composition is comparable to soybean proteins (Sarwar et al., 1978; Wheeler et al., 1980; Lardy et al., 1993; Mawson et al., 1993a; Čerešňáková et al., 2002; and others). The content of sulphur amino acids (methionine, cysteine) in extracted rapeseed meal (ERM) is higher than in soybean meal (Lardy et al., 1993; Mawson et al., 1993a; Fontaine et al., 2001; Čerešňáková et al., 2002). On the other hand, the content of lysine is lower (Fontaine et al., 2001; Čerešňáková et al., 2002) or comparable (Lardy et al., 1993; Mawson et al., 1993a). The energy value of rapeseed diets depends on the content of residual oil left after processing. It is around 35% for rapeseed, around 5 to 10% for rape cake and 1 to 2% for rapeseed meal (Männer, 2001).

Full utilization of rapeseed products is hindered by the presence of antinutritional substances which reduce the utilization of feed nutrients and may even lead to digestive disorders, affect health and reduce animal performance if their concentrations are higher. Among the most important antinutrients, rapeseed contains erucic acid, tannins, saponins, phenolic acids, and above all glucosinolates (GLS). These substances account for the bitter taste of feed, and the products of their ruminal hydrolysis (nitriles, thiocyanates, isothiocyanates)

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show goitrogenic effects, cause inflammations of the digestive tract, kidneys and urinary tract, hepatic and thyroid hypertrophy and reduce the iodine milk content (Papas et al., 1979; Schone et al., 1994; Mawson et al., 1994a; Kalač and Míka, 1997). The long-term feeding of rapeseed diets leads to infertility in cows, reduction in milk production and weight gain and the abortion and stillbirth rates increase (Wemheuer, 1993; Mawson et al., 1994b).

The risk associated with rapeseed feeding has been reduced significantly by the breeding of new oilseed rape cultivars with lower content of GLS and erucic acid. A reduction of antinutrients is likewise enhanced by some technological treatments of extracted rapeseed meal such as extraction or esterification. Nevertheless, the content of extracted rapeseed meal in the rations should not exceed 15 to 25% for cattle, 15 to 20% for dairy cows and 2 to 12% for calves (Männer, 2001).

GLS content remains unchanged in rape cake that has not been subjected to extraction or esterification. The adverse effects of GLS on animal health may be reduced by increasing iodine dietary intake or reducing their levels in the diet by ferric or copper ions, heat treatment and dehulling, exposure to formaldehyde, ammonia, enzymes or some other substances (Schone et al., 1994; Mawson et al., 1995; Šimek et al., 1999).

Some authors (Schingoethe et al., 1974; Sharma et al., 1980; Fiems et al., 1985; Ferlay et al., 1992) reported lower digestibility of rape cake-based diets compared with soybean diets; it may be due to higher lipid levels and higher content of polyunsaturated fatty acids in rapeseed diets (Ferlay et al., 1992). On the other hand, Stake et al. (1973) did not record any differences in digestibility of diets with soybean and rapeseed cake. The differences are likely to be associated with the proportion of rapeseed products in the diet as confirmed by Fiems et al. (1985). They recorded a drop in organic matter digestibility for a starter with 20% content of rapeseed products while no significant drop in digestibility was observed with 10% content.

The use of treated rape cake (TRC) might significantly improve the efficiency and cost effectiveness of calf rearing, especially during transition from the period of milk nutrition to the period of plant nutrition. The objective of the experiment was to assess the effect of a diet with 10% content of treated rape cake and reduced GLS content on calf growth, development and health status.

MATERIAL AND METHODS

Experimental animals

The experiment was conducted on 45 newborn calves (hybrids of 60% of Czech Pied cattle, 30% Ayrshire cattle, 10% Red Holstein cattle). After the first colostrum intake from their mothers, the calves were transferred to open-air individual boxes. Calves were allocated into three comparable groups – S, T and G – with respect to sex, lactation history of their mothers, breed and date of birth. Each group consisted of 15 calves, namely 6 heifers and 9 bulls. The respective groups of calves were kept in open-air individual pens until weaning (at 6 weeks of age), and then they were placed into common open-air pens and to a calf house at 3 months of age.

Feeding

After the first colostrum intake from the mothers, a period of 5 days followed when the calves ingested colostrum from bowls. After the colostrum period the calves were fed 4 l of pooled fresh milk per calf/day. From this moment on, they had free access to one of the three types of starters *ad libitum* up to the age of 90 days. The calves were offered hay *ad libitum* at the age of ten weeks.

Tested starters

Control group S was fed starter Standard, consisting of common components with standard nutrient content including fibre. Comparative group T was fed starter Telstar, which contained whole maize kernels and protein pellets. Experimental group G was fed starter Grant, with 10% content of treated rape cake (commercial name: Proenergol). The rape cake treatment technology designed to reduce the content of GLS consisted in increasing the moisture content of the diet and subsequent heating at 75–80°C and application of oxides and organic acids with specific effects. Since the rape cake treatment technology is the subject of patent No. 285745 (Veterinary Research Institute, Brno, and Agricultural and Commercial Company Žichlínek, Lanškroun, CR; 1999), the specific conditions of the technology cannot be described in detail. The application of this technology leads to a signifi-

Table 1. Starter composition (%)

Ingredient	Starter		
	Standard	Grant	Telstar[3]
Crushed barley	12.0	12.0	
Crushed oats	17.0	17.0	
Coarsely ground corn	20.0	20.0	
Linseed/barley meal (1:1)	6.0	6.0	
Wheat bran	7.8	2.6	
Soybean meal	28.5	24.0	
Whey	4.0	4.0	
Malt sprouts	1.5	1.5	
TRC[1] (Proenergol)	0.0	10.0	
Ground limestone	1.2	1.2	
Dicalcium phosphate	0.9	0.6	
MgO	0.2	0.2	
Aminovit[2]	0.5	0.5	
Feed salt	0.4	0.4	

[1]treated rape cake

[2]vitamins and amino acids (Biofaktor Co. Ltd., Poland)

[3]Starter Telstar composition: granulate:grain = 1:1

Raw materials included in the protein supplement (granulate): cereal products and by-products, oilseed and fruit products and by-products, sugar industry products and by-products, minerals (Ca, P, Na and Mg), vitamins (A, D3, E, B1, B6 and B12), antioxidants BAT, BHA and Ethoxyquin

cant reduction of GLS levels to less than 2 μmol/g of the original matter. The contents of respective feed components in Standard and Grant starters were comparable (see Table 1). The main difference consisted in the replacement of a part of extracted soybean meal and wheat bran in Standard starter by treated rape cake. The producer of comparative starter Telstar does not describe the composition in detail. All three starters were fed in the form of pellets.

Observed parameters

Weight. The calves were weighed immediately after birth and at the end of the experiment (at 90 days of age) and live weight gains for this period were calculated.

Nutrient consumption. The consumption of starters in the three groups was recorded and nutrient consumption was calculated (dry matter, nitrogenous substances, fat, fibre, ash, calcium, phosphorus, magnesium, sodium).

Health status of the animals. The health of the animals was monitored by daily observations. More detailed health checks were conducted by a veterinarian at 10-day intervals. The clinical status and metabolic profile of the animals were assessed by selected clinical-biochemical parameters of blood and rumen fluid and parameters informative of the function of hepatic parenchyma and thyroid gland. Blood was collected from the *vena jugularis externa* on days 7, 30, 60 and 90 of the experimental period. Parameters of the metabolism of proteins (total protein, albumin, urea), lipids (TGC), liver and thyroid gland were analysed using Biola-Tests (Pliva Lachema, a.s.). Iodine concentration was determined by an ashing method and spectrophotometry according to Sandell-Kolthoff (Bednář et al., 1964) and the concentration of thyroid hormones (T_3 and T_4) was determined by the chemiluminescence method (Immulite).

Rumen fluid was collected with a probe by a vacuum method on days 60 and 90 of the experiment in order to assess the ruminal fermentation processes. pH of the rumen fluid was measured, and the num-

Table 2. Starter nutrients content

Nutrient	Absolute dry matter		
	Standard	Telstar	Grant
Dry matter[1] (g)	1 000.00	1 000.00	1 000.00
Dry matter (g/kg)	887.00	872.00	885.00
Crude protein (g)	225.50	178.90	220.30
Fat (g)	36.20	26.10	55.40
Fibre (g)	57.20	42.80	62.80
Ash (g)	68.80	68.50	66.70
Calcium (g)	10.90	11.02	9.39
Phosphorus (g)	6.85	7.20	7.06
Magnesium (g)	3.24	3.51	3.11
Sodium (g)	2.51	2.71	2.54
Zinc (mg)	110.26	95.53	122.6
Copper (mg)	18.94	15.14	20.45
Manganese (mg)	79.93	84.98	84.97

[1]Original dry matter content was 887 g/kg, 872 g/kg and 885 g/kg in the starter Standard, Telstar and Grant, respectively

Table 3. Nutrient consumption (n = 15)

Nutrient	Mean nutrient consumption (calf/day)		
	S	T	G
Dry matter (kg)	1.57	1.90	1.68
Crude protein(kg)	0.34	0.43	0.37
Fat (kg)	0.12	0.12	0.15
Fibre (kg)	0.11	0.11	0.12
Ash (kg)	0.11	0.13	0.11
Calcium (g)	14.60	18.40	13.90
Phosphorus (g)	9.00	11.90	10.10
Magnesium (g)	4.10	5.60	4.30
Sodium (g)	3.40	4.60	3.90

S = control group fed starter Standard with a standard nutrient content

T = comparative group fed starter Telstar, containing whole maize kernels and protein pellets

G = experimental group fed starter Grant with a 10% content of TRC

bers of infusoria were determined in the Fuchs-Rosenthal chamber (Jagoš et al., 1975). Ammonia concentration was measured by a microdiffusion method in Conway vials and the concentration of volatile fatty acids (propionic acid, acetic acid, lactic acid) was analysed by the Cottyn and Boucque method (1968) modified by Jagoš et al. (1977). Thyroid glands were collected from 6 slaughtered animals per group, their weights were recorded and a histological examination was performed.

Statistical analyses

The results were processed and compared using statistical and graphic software STAT Plus (Matoušková et al., 1992). The basic statistical characteristics of the three groups (arithmetic mean, standard deviation, coefficient of variation) were determined and the significances of differences between groups were declared at $P < 0.05$, $P < 0.01$.

RESULTS

Comparison of nutrient content

Nutrient content in three different starters is shown in Table 2. Rape cake inclusion in the experimental starter Grant was reflected in a higher fat content compared with the other two starters. The levels of nitrogenous substances in starters met the requirements of growing calves (Sommer et al., 1994). The lowest consumption per calf over the 90-day period was noted for control starter Standard (120.6 kg), while the highest value was recorded for experimental starter Telstar (154.8 kg). The consumption of experimental starter Grant, containing rape cake, was 130.5 kg. The mean starter

Table 4. Growth responses of calves fed the experimental starters (n = 15)

		Group		
		S	T	G
Mean live weight at birth (kg)	$\bar{x}$	44.00	47.70	42.10
	SD	4.82	4.94	7.43
	V (%)	10.90	10.40	17.70
Mean live weight at 90 days of age (kg)	$\bar{x}$	114.80	114.30	115.70
	SD	16.90	20.50	15.70
	V (%)	14.70	17.80	13.60
Mean live weight gain (kg)	$\bar{x}$	70.80	67.00	73.70
	SD	17.20	18.20	15.20
	V (%)	24.40	27.20	20.70
Mean live weight gain calf/day (g)	$\bar{x}$	787.20	744.50	818.50
	SD	190.90	202.40	169.30
	V (%)	24.20	27.20	20.70
Index (%)		100.00	94.60	104.00

S = control group fed starter Standard with standard nutrient content

T = comparative group fed starter Telstar containing whole maize kernels and protein pellets

G = experimental group fed starter Grant with 10% content of TRC

consumption per calf and day was 1.34, 1.72 and 1.45 kg in groups S, T and G, respectively. The consumption of respective nutrients is summarized in Table 3.

Body weights

The mean live weight of calves at birth was 44.0 ± 4.82 kg; 47.7 ± 4.94 kg and 42.1 ± 7.43 kg in groups S, T and G, respectively (see Table 4). The between-group differences were insignificant. Insignificantly higher body weight was recorded for the calves of experimental group Grant at the end of the experimental period in comparison with the other groups. When the calculated indices were compared, it was obvious that the weight gains obtained with experimental starters Grant and Telstar were by 4.0% higher and by 5.4% lower, respectively, than in the control group Standard.

Blood metabolic profile

No sign of a disease was observed in the calves throughout the experimental period. The levels of selected biochemical parameters (see Table 5) were in the range of reference values (Jagoš and Bouda, 1981) during the whole experimental period. Significant between-group differences were recorded only in the concentration of nonesterified fatty acids. Experimental group G fed treated rape cake did not show any significant differences in iodine, T_3 and T_4 levels compared with S and T groups (Table 6).

Thyroid gland examination

Histological examination of the collected thyroid glands did not reveal any between-group differences in the structure, follicle size and colloid content. The mean weights of the thyroid glands were 16.5 ± 2.8; 11.7 ± 2.2 and 15.5 ± 4.8 g in groups S, T and G, respectively. A significant difference ($P < 0.01$) was detected between groups S and T.

Rumen fluid metabolic profile

The results concerning the rumen fluid metabolic profile are shown in Table 7. The rumen fluid metabolic profile in all three groups of calves corresponded to higher intake of concentrate doses.

Table 5. Blood metabolic profile (n = 15)

Parameter	Collection (days)	S		T		G	
		$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
Total protein (g/l)	7	56.10	5.89	57.90	1.65	60.40	4.70
	30	63.30	3.93	68.40	3.36	66.90	3.54
	60	69.60	4.06	72.10	5.84	68.80	4.51
	90	73.40	3.99	74.50	3.60	75.90	5.30
	$\bar{x}$	65.60	4.47	68.20	3.61	68.00	4.51
Albumin (g/l)	7	21.90	2.41	23.20	2.09	21.30	2.69
	30	36.30	2.07	36.10	3.68	33.80	2.90
	60	33.70	3.59	35.40	3.84	34.30	5.04
	90	34.80	2.52	32.40	3.99	31.60	3.70
	$\bar{x}$	31.70	2.65	31.80	3.40	30.20	3.58
Urea (mmol/l)	7	3.14	0.69	3.83	1.26	4.17	0.89
	30	2.95	0.25	3.16	0.36	3.47	0.54
	60	5.77	0.88	4.74	0.95	5.38	0.61
	90	5.10	1.33	5.47	1.26	5.38	1.06
	$\bar{x}$	4.24	0.79	4.30	0.96	4.60	0.78
Nonesterified fatty acids (mmol/l)	7	0.36	0.08	0.35	0.14	0.49	0.10
	30	0.18	0.04	$0.29^{x,y}$	0.08	0.18	0.05
	60	0.18	0.03	0.17	0.02	0.18	0.03
	90	0.08	0.02	0.08	0.02	0.09	0.01
	$\bar{x}$	0.20	0.04	0.22	0.07	0.24	0.05
Triglycerides (mmol/l)	7	0.19	0.07	0.06	0.05	0.10	0.11
	30	0.04	0.04	0.02	0.02	0.02	0.02
	60	0.05	0.03	0.02	0.02	0.03	0.02
	90	0.09	0.03	0.08	0.02	0.07	0.02
	$\bar{x}$	0.09	0.04	0.05	0.03	0.06	0.04
Cholesterol (mmol/l)	7	1.28	0.33	1.29	0.28	1.37	0.22
	30	2.54	0.77	2.45	0.17	2.76	0.22
	60	1.16	0.44	0.97	0.36	1.12	0.54
	90	1.55	0.28	1.65	0.36	1.76	0.23
	$\bar{x}$	1.63	0.46	1.59	0.29	1.75	0.30

S = control group fed starter Standard with standard nutrient content

T = experimental group fed starter Telstar containing whole maize kernels and protein pellets

G = experimental group fed starter Grant with 10% content of TRC

The profile indicated chronic ruminal acidosis, particularly at the first examination at 60 days of age. These changes were most marked in groups G and T. The momentary rumen fluid acidity dropped to the value 5.64 ± 0.28 in group G and to 5.92 ± 0.34 in group T. The acidity was 6.12 ± 0.39 in group S. The total levels and proportions of respective volatile fatty acids likewise suggested chronic ruminal acidosis. The level of acetic acid decreased to 50.4 mol/100 mol in group G and to 46.0 mol/100 mol in group T; those differences were significant ($P < 0.05$) compared with group S. On the other hand, higher

Table 6. Plasma levels of iodine and thyroid gland hormones (n = 15)

Parameter	Collection (days)	S		G		T	
		$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
Iodine (µg/l)	7	288.90	143.00	234.80	41.90	210.50	76.10
	30	246.70	104.80	220.20	58.80	190.60	44.90
	60	185.70	17.10	144.5**	13.20	89.2**	23.10
	90	114.10	20.70	139.80	25.20	118.10	27.80
	$\bar{x}$	208.90	71.40	184.80	34.80	152.10	43.00
T_3 (nmol/l)	7	6.53	2.27	4.64	1.42	5.22	2.15
	30	3.45	0.73	3.82	1.02	3.62	0.70
	60	2.93	0.62	3.13	0.80	2.18	0.53
	90	3.18	0.29	3.42	0.74	3.01	0.62
	$\bar{x}$	4.02	0.98	3.75	1.00	3.51	1.00
T_4 (nmol/l)	7	130.20	62.00	93.70	42.30	111.20	51.00
	30	69.20	13.90	63.10	24.60	66.40	22.50
	60	57.10	14.40	40.50	15.50	57.90	21.60
	90	54.80	14.70	54.70	14.80	50.70	25.00
	$\bar{x}$	77.80	26.30	63.00	24.30	71.50	30.00

S = control group fed starter Standard with standard nutrient content

T = comparative group fed starter Telstar containing whole maize kernels and protein pellets

G = experimental group fed starter Grant with 10% content of TRC

**$P < 0.01$

levels of propionic acid were detected in groups G and T, i.e. 30.8 mol/100 mol and 32.2 mol/100 mol, respectively; however, the differences were insignificant.

DISCUSSION

It follows from the results of the present study that calves ingested experimental starter Grant containing TRC very well. The heat and chemical treatment of rape cake reduced the GLS level sufficiently resulting in good taste and adequate feed consumption. The adequate consumption of rape cake diet is in agreement with the results reported by other authors (Papas et al., 1979; Fisher, 1980; Wheeler et al., 1980; Ferlay et al., 1992). Impaired feed taste and decreased consumption are usually observed when rapeseed products with high GLS levels are fed to calves (Schingoethe et al., 1974; Papas et al., 1979; Mawson et al., 1993b; 1994a). Fiems et al. (1985) recorded a drop in the rape cake starter consumption in favour of an increased consumption of hay. The drop was insignificant when the diet contained 20% of rape cake with low GLS content, but significant when the diet contained rape cake with high GLS content. Despite these statistical differences, no reduction in feed conversion was observed.

The optimum intake of experimental starter Grant containing TRC resulted in favourable weight gains in the calves. The body weight of group G calves was insignificantly higher at the end of the experimental period in comparison with the other calves. A similar trend was recorded by Wheeler et al. (1980). Calves fed rapeseed products with low GLS content reached higher weight gains in the post-weaning period compared with calves fed a soybean starter, but the differences were insignificant. Fiems et al. (1985) observed insignificant changes in weight gains between the calves fed starters containing 10% in comparison with 20% of rapeseed products. GLS content is one of the crucial factors characterizing rapeseed products. Diets with higher GLS content lead to lower weight gains in the animals (Stake et al., 1973; Schingoethe et al., 1974; Paps et al., 1979; Fiems et al., 1985).

Table 7. Rumen fluid metabolic profile (n = 15)

Indicator	Sampling (days)	S		T		G	
		$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
pH	60	6.12	0.39	5.92	0.34	5.64	0.28
	90	6.44	0.35	6.54	0.23	6.39	0.48
	$\bar{x}$	6.28	0.37	6.23	0.29	6.02	0.38
NH_3 (mmol/l)	60	10.60	3.84	13.00	3.36	10.30	2.58
	90	9.77	4.32	12.70	5.59	10.10	5.74
	$\bar{x}$	10.20	4.08	12.80	4.48	10.20	4.16
Infusoria (10^3/ml)	60	588.00	107.00	608.00	141.00	556.00	97.00
	90	343.00*	126.00	440.00	98.00	529.00	98.00
	$\bar{x}$	466.00	117.00	524.00	120.00	543.00	98.00
Lactic acid (mmol/l)	60	0.96	1.21	0.25	0.35	0.93	1.70
	90	0.38	0.34	0.96	1.15	0.92	1.03
	$\bar{x}$	0.67	0.78	0.61	0.75	0.93	1.37
Acetic acid (mol/100 mol)	60	52.80	4.74	46.0*	4.33	50.40	3.57
	90	59.10	7.76	59.00	5.85	55.40	9.24
	$\bar{x}$	55.90	6.25	52.50	5.09	52.90	6.41
Propionic acid (mol/100 mol)	60	27.20	1.37	32.20	6.93	30.80	5.32
	90	25.10	9.25	22.30	5.36	24.30	9.94
	$\bar{x}$	26.10	5.31	27.20	6.15	27.50	7.63
Total VFA (mmol/l)	60	156.50	34.50	147.60	27.90	167.20	27.40
	90	121.20	22.80	109.30	16.10	139.70	53.60
	$\bar{x}$	138.80	28.70	128.40	22.00	153.40	40.50

S = control group fed starter Standard with standard nutrient content

T = comparative group fed starter Telstar containing whole maize kernels and protein pellets

G = experimental group fed starter Grant with 10% content of TRC

VFA = volatile fatty acids

*$P < 0.05$

The diet with 10% content of TRC had no adverse effects on the health of calves. No significant changes in the metabolic profile of animals were observed. The higher proportion of fat in rape cake in experimental starter Grant did not cause any significant changes in plasma triglyceride and cholesterol levels. A significant increase in plasma lipid levels was observed by Dvořák et al. (2000), with a TRC diet containing 12.8% of residual oil. The authors also recorded significantly ($P < 0.01$) lower plasma urea levels in experimental dairy cows due to lower rumen degradability of heat-treated rapeseed proteins. In our experiment the blood urea levels in calves were insignificantly higher in experimental group G compared with group S at the beginning of the experiment only (days 7 and 30 of the experiment). Further blood sample analyses on days 60 and 90 of the experiment showed a return to physiological values compared with the control group. A similar course of changes was observed in comparative group T.

No goitrogenic effect of GLS content in TRC included in the diet was observed throughout the experiment. Iodine and thyroid hormone levels in group G were comparable with those in the control group. T_4 concentrations showed slightly lower levels at the first sampling immediately after birth and at subsequent collections on days 30 and 60, but the differences were insignificant (see Table 6). It may therefore be stated that TRC had no adverse ef-

fect on T_4 levels. The thyroid glands of calves from group G collected at the end of the experimental period did not show any change in size, weight and structure. Papas et al. (1979) concluded that the increased thyroid gland weight was associated with diets containing higher amounts of GLS. This is in accordance with the findings published by Mandiki et al. (2002), who did not record any drop in thyroid hormone levels in lambs fed a diet containing a high proportion (40%) of low GLS rape cake. In our experiment, the proportion of rape cake in the diet was relatively low and the potential goitrogenic effect was reduced sufficiently by an efficient heat and chemical rape cake treatment.

General assessment of the rumen fluid metabolic profile at 60 days of age showed that chronic ruminal acidosis resulted from the intake of starters uncompensated by an adequate intake of forages. This situation was also reflected in a drop in rumen fluid acidity and concentration of acetic acid and in an increase in concentrations of propionic acid and total volatile fatty acids. The effect of the respective starters on the above changes in the profile was insignificant. The testing performed at 90 days of age showed a return of the metabolic profile parameters to the levels corresponding to balanced feed rations. All monitored parameters describing the fermentation processes were within reference ranges. We can therefore conclude that the 10% content of TRC in the starter had no adverse effect on ruminal fermentation in the calves. Hay consumption contributed to the stabilization of ruminal fermentation at the end of the experiment, without significant effect of the respective starters.

Dvořák et al. (2000) recorded insignificantly higher pH and significantly lower ($P < 0.01$) ammonia levels in the rumen fluid of cows fed a diet with 35% content of TRC compared with dairy cows fed a diet with 35% content of extracted soybean meal. They ascribed these differences to a lower degradability of heat-treated rape cake proteins. Lardy et al. (1993) likewise recorded higher pH values and lower ruminal degradability of rape cake proteins compared with soybean proteins in their study. On the contrary, Fiems et al. (1985) documented a better solubility of rapeseed proteins leading to their better degradability in the rumen compared with soybean proteins. The variation in these degradability values could be attributed to several factors. First of all, variation in the way of meal processing during the toasting phase of crushing can have a large effect on meal degradability. High temperatures during the toasting phase may result in lower ruminal degradabilities and higher ruminal escape values. Other factors contributing to variation in rumen degradabilities are soil conditions, climate, and geographic location where the rapeseed was grown (Hill, 1991).

CONCLUSION

The diet containing 10% of treated rape cake with low GLS content had no adverse effect on calf growth and development. No significant changes in the parameters describing nitrogenous, energetic, lipid and health status and hepatic parenchyma and thyroid gland function in the calves were observed after the *ad libitum* feeding of this diet for 90 days.

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