BY-PRODUCTS FROM RAPESEED PROTEIN CONCENTRATE (RPC) PROCESSING AS FEED-STUFFS. I. FINES TO DAIRY COWS.

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The processing of rapeseed protein concentrate (RPC) from rapeseed (RS) yields not only RPC (23-28 %) and oil (32-42 %) but also the by-products hulls (12-15 %) fines (3-10 %) and evaporated aqueous extract (13-16 %) (Anjou and Fecske, 1974). Expeller-crushed fines (FE) are similar to rapeseed meal (RSM) but have a slightly finer particle structure and higher contents of fat and glucosinolates (GLS). RSM has been successfully tested in long-term Swedish experiments with up to 10 % RSM in concentrates to dairy cattle (Lindell and Knutsson, 1976; Lindell, 1976). - The present experiment was designed to study whether the good result given by RSM could be repeated with a concentrate mixture containing 7.5 % FE to first-lactation cows.

MATERIAL AND METHODS

FE, based on high-glucosinolate winter rape (Br. napus), had been processed by AB Karlshamns Oljefabriker, Karlshamn. The expellers had been de-fatted by screw pressing. The chemical composition and nutrient content of the FE are given in Table 1. The material was incompletely heated and had a low myrosinase activity (0.5 µmol/min/g). GLS content calculated as the split products isothiocyanate (ITC) and oxazolidinethione (OZT) was 18.6 g/kg. Values obtained by Petersson (1975) in a metabolism experiment with sheep were used in calculating the nutrient content of FE.

TABLE 1

CHEMICAL COMPOSITION AND NUTRIENT CONTENT OF FINES ON DM BASIS

Dry matter	91.6	Glucosinolates, g/kg	68.6
Crude protein, %	38.3	Isothiocyanates, g/kg	4.9
Ether extract, %	9.6	Oxazolidinethiones, g/kg	15.4
Crude fibre, %	10.9	Myrosinase activity, µmol/min/g	0.16
Ash, %	6.8	ME MJ/kg	13.6
		Dig. crude protein, g/kg	321

The experiment was conducted at the Alnarp Research Station on individually fed first-lactation dairy cows (Swedish Frisian Breed) divided into two equal groups as regards milk yield during lactation weeks 2-10 (pre-period), body weight, age and ancestry. During the experimental period (weeks 11-40) comparisons were made of two concentrate mixtures. The experimental mixture (Treatment 2) contained 7.5 % FE, which replaced 8 % cottonseed expeller (CE) in the control mixture (Treatment 1). The compositions of the respective concentrate mixtures are given in Table 2.

During the pre-period the maintenance requirements of the cows (0.507 x $W^{0.75}$ MJ ME and 6.2 g dig. crude protein (DCP) per MJ) were covered by 4 kg hay and 2.2 kg organic-matter (OM) grass silage per day. The hay in this ration was replaced by straw plus 1.3 kg concentrate during the experimental period. During most of the experiment the silage was of sugar-beet

TABLE 2

COMPOSITION OF CONCENTRATE FEED MIXTURES, THEIR NUTRIENT CONTENT, FEED CONSUMPTION, PERFORMANCE RESULTS AND CHEMICAL COMPOSITION OF THE MILK (16 ANIMALS PER TREATMENT)

	Pre-period (w. 2-10) Treatment		Exp. period (w. 11-40) Treatment	
	1	2	1	2
Ingredients in concentrate mixture, %				
Roller-milled barley-oats (1:1)	57		59	59
Molassed dried beet pulp	20		20	20
SBOM	8		13	13.5
Cottonseed expeller	9.5		8	-
RSM	5.5		-	-
Expeller-crushed fines	-		-	7.5
Nutrient content of concentrates				
ME, MJ/kg	10.96		11.09	11.25
Dig. crude protein, g/kg	128		131	132
Feed consumption				
Roughage, kg DM	357	352	1,251	1,249
Concentrates, kg	684	666	2.129	2.128
ME, MJ/day	172.4	168.8	161.0	162.5
Dig. crude protein, g/day	1,814	1,774	1,653	1,657
Performance results				
Milk, kg/day	24.37	24.11	18.11	18.90
4 %-FCM milk/day	24.11	23.99	17.94	18.31
ME, MJ/kg FCM	7.15	7.03	8.98	8.88
Prod. ME[1], MJ/kg FCM	5.15	4.97	5.01	5.17
Average body weight, kg	548.8	532.8	567.6	547.3
Change in body weight, kg	-14.2	-10.2	+57.6	+50.2
Milk composition				
Fat, %	3.93	3.97	3.94	3.79
Protein, %	3.26	3.30	3.56	3.57
Dry matter, %	12.57	12.67	12.80	12.63
Iodine no. of milk fat	30.1	29.4	29.8	30.5

[1] See Results

tops. The concentrate ration was adjusted weekly in relation to the previous week's milk yield (5.0 MJ ME and 60 g DCP per kg 4 % FCM). Corrections were also made for weight gain (up to 625 kg), maintenance and gestation. The cows were given minerals and vitamins. Feeding and milking were done twice daily. The cows were kept tied up and all feedstuffs were weighed individually, refusals being deducted. The cows were weighed two days after calving and subsequently every fourth week throughout the experiment.

Milk yields were measured individually five days a week. Butterfat and dry matter were determined weekly on pooled samples. Milk protein was determined at four-weekly intervals. A similar bulk sample was used to determine iodine at two-weekly intervals.

Blood samples were taken on 4 occasions for determination of haematological status and on 3 occasions milk samples were taken for SCN--determinations (analyzed at the Dept. of Clinical Biochemistry, Swedish Univ. of Agric. Sciences).

The statistical evaluation was made with covariance analysis for production traits with the pre-period as independent variable and the experimental period as dependent. Analyses of variance were made of the clinical parameters.

RESULTS

The cows ate the concentrate with very few refusals (Table 2). For both treatments the concentrate consumption per day was 10.1 kg while the energy intakes were 161.0 and 162.5 MJ for Treatments 1 and 2 respectively. The average concentrate consumption for Treatment 2 corresponded to 0.69 kg FE which represented an intake of 0.09 g OZT + ITC per MJ, or 0.13 g per kg metabolic body weight (m.b.w.). The highest daily intake of FE during a lactation week was 0.79 kg. The consumption of crude fat per kg FCM was 23.8 and 24.3 g for Treatments 1 and 2 respectively.

The average milk yields during the experimental period and the milk's chemical composition (corrected to the same result during the pre-period) for Treatments 1 and 2 respectively were: 18.1 and 19.0 kg milk, 17.9 and 18.3 kg FCM, 3.96 % and 3.79 % fat ($P = 0.065$), 3.59 % and 3.57 % protein, 12.8 % and 12.6 % dry matter. The corresponding values for feed efficiency expressed in MJ per kg FCM were 8.98 and 8.88, respectively, and after reduction for maintenance, weight gain and gestation (ME prod.) 5.01 and 5.17 MJ, respectively.

Haematological and clinical-chemical investigations gave the following results expressed as means for Treatments 1 and 2, respectively (per 100 ml): haemoglobin 12.4 and 11.8 g ($P = 0.063$); (serum) glucose 42.2 and 43.4 mg, urea-N 13.9 and 12.2 mg ($P < 0.01$), total protein 7.6 and 7.7 g, albumin 4.2 and 4.2 g, total iodine 8.5 and 9.0 µg, PBI 4.8 and 4.5 µg, SCN^- 0.13 and 0.74 mg ($P < 0.001$). The blood parameters were within the normal variation apart from the high SCN^--level in Treatment 2. SCN^--levels in the milk were 0.13 and 0.34 mg per 100 ml ($P < 0.001$), respectively.

The health condition of both groups was normal for the herd. One cow in Treatment 1 and two in Treatment 2 did not succeed in becoming pregnant. The statistical calculations on production traits were also done with these cows excluded, but the results remained the same. The average calving intervals were 375 and 394 days for Treatment 1 and 2, respectively. The number of inseminations (a.i.) per pregnancy were 1.2 and 1.9 ($P < 0.05$), respectively. There was a faster decline in milk yield the last weeks of the experiment for Treatment 1, which was more pronounced than could be explained from the difference in the stage of pregnancy between treatments.

DISCUSSION

When discussing the use of RS products as feedstuffs it is important that attention is paid to the content and type of GLS in them and to the myrosinase activity.Cultivation of winter rape (Br. napus) dominates in Sweden. Br. napus generally contains larger quantities of GLS than campestris, and especially of progoitrin which can result in the split product OZT which is considerably more toxic than ITC (Bell and Belzile, 1965). The amounts of OZT and ITC in the present experiment calculated in relation to energy intake and the animal's m.b.w. were higher than in the earlier mentioned Swedish experiments with RSM (Lindell and Knutsson, 1976; Lindell, 1976). In the latter experiments the highest RSM level (10 %) was equivalent to 0.07 g per MJ ME or 0.09 g/kg m.b.w. as opposed to 0.09 and 0.13 g/kg in the present experiment.

According to the literature on the feeding of RSM to cows, no clear influence of GLS has been demonstrated, apart from the palatability of the feed and in some Canadian works a lowering effect on the thyroxine level in blood serum (Fisher and Walsh, 1976; Sharma et al., 1977). The enhanced levels of SCN^- in the blood and milk in the present experiment must be regarded as reflecting the SCN^--forming products in the FE. The same pattern was also obtained in the RSM experiments mentioned above. Controls without RSM gave SCN^--levels per 100 ml of 0.05 and 0.01 mg for blood and milk, whereas 10 % RSM gave 0.57 and 0.20 mg (Iwarsson, 1973 a, b; Iwarsson and Ekman, 1974). The increase of OZT + ITC in the present experiments in comparison with the latter resulted in approximately corresponding increases in the SCN^- -contents of both blood and milk. Increase of the SCN^--content of the milk was also noted when feeding high quantities of RSM by Hoppe et al. (1971).

No health disturbances due to feeding with FE were observed but the results indicate a poorer fertility in Treatment 2. The material is too small for definite conclusions to be drawn. However, similar trends were noticed in earlier trials with RSM (Lindell and Knutsson, 1976; Lindell 1976; Ingalls and Seale, 1971), which motivate further experiments into the effect of RS products on bovine fertility. A reason for the more pronounced effect on fertility in the present experiment could be the higher myrosinase activity of FE compared with RSM.

The production results and the feed consumption were very similar in both treatments, and indicate that the values obtained by Petersson (1975) for FE are reasonable. Treatment 2 had an almost statistically significant lower fat content in the milk but this was compensated fully by a higher quantity of milk. The lower fat content might have been an effect of the RS oil containing more unsaturated fatty acids than the CE (Moore and Steele, 1968; Christensen, 1970). However, there were no decreases in fat content when rapeseed was fed (Homb, 1961:, Frank, 1978). The very fine structure of FE might possibly be a fat-depressing factor. The trend of higher iodine values reflects the content of unsaturated fatty acids of the RS oil and also agrees with the results of Homb (1961) and Frank (1978). With regard to winter feeding, it is usually an advantage to have a concentrate which boosts the iodine value.

In conclusion we can state that FE can be used up to 7.5 % in a concentrate mixture to dairy cows. The slightly lower fat content is well compensated by an increased milk yield. The indication of an inferior conception rate among cows fed FE should not be neglected and should be studied further.

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