RAPESEED PRODUCTS OF 00-CULTIVARS TO DAIRY COWS. EFFECTS OF LONG-TERM FEEDING ON ANIMAL PERFORMANCES

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INTRODUCTION

Rapeseed (Brassica napus oleifera and Brassica campestris oleifera) is the most important oilseed crop grown in Sweden. However, the use of rapeseed in dairy cow rations has been restricted to 1 kg rapeseed meal (RSM) per day because of the risks of negative effects on animal health, particularly on fertility, caused by the glucosinolates. A tendency towards an increased number of artificial inseminations (AI) per conception was also reported when up to 1.39 kg RSM with a high content of glucosinolates was fed (Lindell, 1976).

Double low (00) rapeseed, with low levels of erucic acid and glucosinolates was introduced by plant breeders in the early seventies. Since then, there has been an increased interest in Sweden, among farmers as well as the feed industry to use 00-rapeseed in dairy cow rations. Several short-term studies have been conducted (Laarveldt et al., 1981; Sanchez and Claypool, 1983; DePeters and Bath, 1985, among others), and up to 3 kg 00-RSM have been fed per day, during periods of 35 days to 4 months, without negative effects, either on milk production or on the thyroid gland (Laarveldt et al., 1981b).

However, the effects of feeding high amounts of 00-rapeseed products to dairy cows for a longer period have not been studied. Therefore, this study was initiated with the intention of studying the effects on milk production, feed efficiency, fertility, health and milk quality when high levels of 00-rapeseed products were fed during three consecutive lactations.

MATERIALS AND METHODS

During the fall of 1982 and 1983, 85 primiparous cows of the Swedish Red and White Breed were randomly allotted to one of three different feeding regimes with no rapeseed (SS), medium level (RS) and high level (RR) of rapeseed products included in the concentrates. The heifers were introduced two weeks before predicted calving time and remained in the same treatment group for three consecutive lactations.

The concentrate mixtures were composed such that the cows in group RR were fed up to 3 kg dry matter (DM) per day of rapeseed products, calculated as fat free meal (up to 2.5 kg DM 00-RSM and 0.9 kg DM heat-treated and crushed full fat rapeseed (00-HR)). In group RS the cows were fed a maximum amount of 1.65 kg DM rapeseed products, almost exclusively 00-RSM. These maximum levels were fed at a milk production of about 30 kg 4% fat corrected milk (FCM). The cows on treatment SS did not receive any rapeseed at all. The RSM was primarily replaced by soybean meal and rapeseed fat was mainly replaced by tallow and to a minor extent by cottonseed and coconut fat.

The cows were fed a constant amount of concentrates during lactation weeks 4-13, depending on their individual milk production during the first three weeks. Thereafter they were fed according to current Swedish standards for milk production, i.e. 5 MJ metabolizable energy (ME) and 60 g digestible crude protein (DCP) per kg of FCM (see also Emanuelson, 1989). The three diets were kept isonitrogenous and isocaloric and contained approximately 5% crude fat. All cows were fed equal amounts of forage per day, 6.5-7.5 kg DM of grass silage and 1.2-2 kg DM of grass hay. The average percentages of concentrate in total rations were 48-57%, in early lactation.

The glucosinolate content in the rapeseed products varied between 7-36 μmol/g fat free meal. The 00-TWR was obtained from the Farmers' Supply and Crop Marketing Association. This rapeseed was heat- and steam treated until the whole batch of rapeseed reached a temperature of 95°C and a water content of approximately 16%. Finally the rapeseed was crushed and dried.

Feed samples were analyzed for content of estrogenic substances and fatty acids, besides all common nutritional analyses. Milk samples were tested weekly for fat, protein and solids and five times/lactation for iodine, thiocyanate, urea, fatty acids and taste. During the first ten weeks of lactation, milk samples were also analyzed for acetone by flow injection analysis. The analyses on feed and milk followed standard laboratory procedures (Emanuelson, 1989).

The reproductive status of each cow was monitored by clinical gynecological examinations once a week from calving until the first AI. Simultaneously, whole milk samples were collected for analysis of progesterone (RIA-kit, Farmos, Turku, Finland). Heat signs were recorded three times daily by the herdsmen. TRH-tests (Thyrotropin Releasing Hormone) for the assessment of thyroid function were performed 30 and 300 days after calving (Laarveldt et al., 1981b).

The effect of treatment on the various measurements was analyzed by least square analyses as applied in the General Linear Models procedure of SAS (SAS Institute Inc.,1985) For further information concerning the statistical models, see Emanuelson (1989).

RESULTS

Feed refusals were small and intake of DM, crude protein (CP), DCP and estimated ME were not significantly affected by diet in any of the three lactations. The highest levels of rapeseed were fed in group RR during lactation 3. The maximum daily amounts were 2.5 kg DM RSM plus 0.9 kg DM TWR.

During the first three months of lactation 1, the average daily intakes of glucosinolates were 34 and 53 mmol in treatments RS and RR, respectively and during lactation 2 the average daily intakes, during the same period, were 34 and 58 mmol, respectively. Since the glucosinolate content in the rapeseed decreased over the years, the daily intakes were lower when the cows entered lactation three (24 and 40 mmol per day, respectively). The maximum daily intake, for an individual cow, never exceeded 80 mmol, which was almost reached by some cows on treatment RR, during lactation 2.

There were no significant differences between the three treatments in total amount of milk produced . Also the yield of 4% fat corrected milk, fat and total solids, as well as contents of fat and solids, were not significantly affected by diet (Table 1). During the whole experiment there was a tendency towards higher milk protein content in group RR than in group SS. This difference was statistically significant ($p<0.05$) only during the first lactation. When the results from all three lactations were run in the same statistical model, both the amount and the concentration of milk protein were significantly higher in treatment RR than in SS. Also group RS tended to produce more protein than SS. Milk urea was significantly higher ($p<0.05$) when diet SS was fed than when any of the two rapeseed diets were fed. The same result was obtained in all three lactations and at all stages of lactation (Table 1).

Table 1. Milk production and composition for the first 44 weeks of lactation 1-3. Least square means and standard errors (SE)

	Treatment			
	SS	RS	RR	SE
Milk yield, kg				
lactation 1	5671	6052	5875	187-200
2	6348	6724	6843	199-212
3	7231	7515	7127	214-241
Fat, %				
lactation 1	4.58	4.60	4.61	0.05
2	4.59	4.59	4.60	0.05-0.06
3	4.57	4.57	4.55	0.06-0.07
Protein, %				
lactation 1	3.22[a]	3.26[ab]	3.35[b]	0.04
2	3.25	3.29	3.32	0.03
3	3.23	3.31	3.37	0.04-0.05
Urea, mmol/l				
lactation 1	5.44[a]	5.10[b]	5.11[b]	0.26*
2	5.93[a]	5.39[b]	5.59[b]	0.33*
3	5.95[a]	5.12[b]	5.27[b]	0.30*

[a,b] Means in the same row without a common superscript are significantly different ($p<0.05$).
* Least significant differences.

There were no differences between the three groups in the total number of cows treated for lack of appetite (Table 2). Furthermore, statistical analyses of average and maximum milk acetone values from each cow, did not show any significant differences between treatments (values not shown). Table 2 also shows that there were no differences in total disease rate between the three treatments. A higher number of incidences of mastitis in group SS can, however, be discerned as well as a somewhat higher number of acyclic cows on treatment RR.

Table 2. Number of cows affected (and treated) by some common diseases or fertility disorders, lactation 1-3

	Treatment		
	SS	RS	RR
Acyclic	7	5	13
Cystic ovaries	9	6	9
Endometritis	3	5	5
Retained placenta	2	3	0
Mastitis	18	11	14
Bloat	2	2	6
Laminitis	7	5	7
Lack of appetite	17	21	20
Diarrhoea	12	16	10

Preliminary results from studies on fertility showed no significant effects that were consistent during the whole experiment. For the primiparous cows, the interval from calving to conception (CC) tended to be longer ($p=0.10$) for treatment RR (115±7.7 days) than for SS (96±7.3 days). Treatment RR also had the highest number of AI per conception and the longest calving interval, although not significantly different from the other treatments. The same trends were not seen in the following two lactations. In lactation 2, the highest number of AI/conception was actually obtained for treatment SS and no treatment effect at all could be seen for the CC-interval .

The release of thyroid stimulating hormone (TSH) after stimulation with TRH was significantly higher (students t-test) for the cows on treatment RR than for those on treatment SS, during the first lactation. The release of TSH for the cows on treatment RS was of the same level as for the RR-group, but the variation was larger and therefore not significantly different from group SS. These results, as well as the above mentioned concerning fertility, are still only preliminary, but the tendencies seen are probably not going to change.

High (RR) as well as low (RS) levels of rapeseed in the diets resulted in significantly increased concentrations and amounts of thiocyanate in the milk. The levels in the two rapeseed groups did not differ. For milk iodine the results were the opposite, with significantly reduced concentrations and amounts in the two rapeseed groups. In a study with rats which were fed milk from the three treatment groups, there were no metabolic disorders in the rats fed "rapeseed milk", that could be related to the glucosinolates or their metabolites. Neither were there any differences between the treatments in live weight gain nor in the organ weights, registered at slaughter.

Milk fatty acid composition was affected by the inclusion of TWR (treatment RR), The proportion of C16:0 decreased by approximately 5 percentage units and C18:0 plus C18:1cis increased by the same magnitude, compared to when other fat sources were fed, as in treatments SS and RS. Finally, the organoleptic test covering all three lactations did not reveal any significant differences in scores between the treatments.

DISCUSSION

The results from this experiment show that 00-rapeseed is a palatable feedstuff and even at daily intakes of 2.5 kg DM RSM plus 0.9 kg DM TWR there were no signs of increased refusals. These results are also in line with earlier short-term studies, which showed that 00-RSM can effectively replace soybean meal (e.g. Papas et al., 1978; Laarveldt et al.,1981a) or cottonseed meal (DePeters and Bath, 1985) without negative effects on feed intake. Others have shown that consumption rate has been slowed down when more than 25% (1.2 kg) 00-RSM (Frederiksen et al., 1979) or more than 40% RSM, irrespective of glucosinolate content (Dedenon, 1985), was included in the dairy cow rations. However, the risks of encountering palatability problems seem to be small, as long as 00-cultivars are being used.

There are several possible explanations for the higher milk protein production and concentration obtained when rapeseed products were included in the rations, compared to when no rapeseed was fed. Different supplies of individual amino acids from the three diets may have played a role. In the present experiment the supply of methionine was somewhat higher in the two groups fed rapeseed than in group SS (approximately 10 g more per day, at a production level of 30 kg FCM). It has been shown that an extra supply of methionine, either post-ruminally (Clark, 1976) or when fed orally (Doyle and Bird, 1975) can have a positive effect on milk protein content.

Another possible explanation might be a slightly higher microbial protein production in the rumen and/or a somewhat higher rate of passage of undegraded protein to the duodenum. This was also confirmed by lower milk urea levels obtained for treatments RR and RS. Milk urea has a high correlation with blood urea and ammonia production in the rumen (Kaufmann,1982) and has been suggested as a possible indicator of the nitrogen utilization.

The milk produced from the rapeseed fed cows was of high quality. The taste scores were high and the presence of antinutritional substances was low. Although the levels of thiocyanate in the milk from the rapeseed fed cows (0.07-0.14 mmol/l) were significantly higher than in the milk from treatment SS, these levels are far below the level required (3.4 mmol/day) for development of goitrogenic symptoms in man (Vilkki et al., 1962). Finally, the changes obtained in milk fatty acid composition by feeding TWR are very positive from a human nutritional standpoint and will also make the butter more spreadable.

CONCLUSIONS

The inclusion of 00-rapeseed products up to about 3 kg fat free DM/day did not negatively affect the production results and even tended to increase the milk protein content and production. The general health status of the cows was not affected, apart from some tendencies towards negative influences on the fertility of the primiparous cows.The concentrations of goitrogenic substances obtained in the milk at the above mentioned rapeseed levels (corresponding to an average glucosinolate intake per cow of about 40 mmol/day), were well below levels considered harmful to humans. From a human nutritional standpoint, a slightly better milk fat was obtained.

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