RAPESEED MEAL AS A PROTEIN SUPPLEMENT FOR GROWING CATTLE: EFFECT ON VOLUNTARY FEED INTAKE AND ANIMAL PERFORMANCE

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INTRODUCTION

Rapeseed meal (RSM), as a protein supplement for growing bulls, has been intensively studied in Finland during the last few years (Huhtanen et al. 1985; Huhtanen et al. 1989; Aronen 1990; Aronen 1991). However, the results have been somewhat contradictory. Possible reasons for these discrepancies may have been related to differences in diet composition including e.g. nutritional quality of roughage, differences in feeding level of the cattle in relation to their growth potential and finally, differences between the RSMs.

In the first one of the serie of three experiments conducted in the Agricultural Research Centre, Finland, RSM supplementation increased voluntary hay intake but not that of grass silage in growing Ayrshire bulls. An increase in live weight gain (LWG), being consistent throughout the experiment for the hay-fed animals, was observed only below live weight of 250 kg in the grass silage-fed animals. In the second experiment RSM supplementation increased voluntary grass silage intake and thereby also LWG, but feeding frequency (once or twice daily) of RSM was without an effect. In the present paper the results of these two experiments (Aronen 1990; Aronen 1991) are only briefly discussed, the main emphasis being on the third experiment, in which the effects of heat-moisture treatment (hmt) and variety of rapeseed were studied.

MATERIALS AND METHODS

Fifty Finnish Ayrshire bull calves, within ten replicates, were randomly alloted into five treatments (A, B, C, D and E). Two of the animals, one in each of treatments C and E, were lost during the course of experiment for reasons not related to the treatments.

Direct-cut grass silage, ensiled in tower and bunker silos with a formic acid based additive (5 l/t), was fed ad libitum. The daily allowance of concentrates was gradually increased from 1.5 kg at the start of the experiment to 4.0 kg at the end. The concentrate in treatment A was barley. In treatments B to E 500 g of barley was replaced by different types of RSM. For the production of RSM in treatment B (RSM-1), a blend of rapeseeds (Brassica campestris), which represented the varieties grown in 1988 in Finland, was used. The quantitatively most important variety at that time was a 0-variety Emma. The RSM in treatment C (RSM-2) was produced of 00-variety named Kova. In order to decrease the rumen degradability of protein the RSM-2 was exposed to heat-moisture treatment (Öpex®). Despite the differences in variety, the RSM-1 and RSM-2 are together regarded as black-seeded varieties in this paper. The RSM in treatment D (RSM-3) originated from 00-variety, called Esko.

A yellowish colour is typical for this variety. The RSM in treatment E (RSM-4) was of the same origin with the RSM-3 with the exception that it was treated as RSM-2. RSM-3 and RSM-4 are together regarded as yellow-seeded varieties. To achieve a similar fat content for all diets 30 g of barley in treatment A was replaced by rapeseed oil. A commercial mineral mixture was given at the rate of 150 g/d throughout the experiment.

The experiment was started at the average age of 15 weeks and it lasted for ten 4-week periods. The experimental period was further subdivided in two parts of 20 weeks each (period 1 and 2). The animals were weighed at the start of the experiment and on the last day of each 4-week period. They were fed individually and feeds offered and refusals were recorded daily.

Metabolizable energy (ME) values of the feeds were calculated according to MAFF (Anon. 1975). Degradability of crude protein (DEG) of the four different RSMs was estimated in rumen-fistulated Ay-bulls as described by Vanhatalo and Aronen (1991) and DEG values of 0.80 for grass silage (Spröndly 1989) and 0.75 for barley (Aronen 1990) were adopted.

The model used to analyse the average feed intake, growth, diet digestion and slaughter data included the effects of replicate and treatment, respectively. The treatment effect was further partitioned, using orthogonal contrasts, into effect due to RSM (A v. other treatments), into effect caused by variety (B,C v. D,E), into effect caused by hmt (B,D v. C,E) and into interaction effect of variety and hmt (B,E v. C,D). However, it has to be recognized, that the variety effect was confounded, because the black-seeded varieties of RSM-1 and RSM-2 were not the same.

RESULTS

The results are given in the three tables below; chemical composition and feed values of the experimental feeds in Table 1, feed intake in Table 2 and animal performance in Table 3.

Table 1. Chemical composition of the experimental feeds (g/kg dry matter (DM)) and evaluated feed values

	Grass silage	Barley	RSM 1	RSM 2	RSM 3	RSM 4
Dry matter (g/kg)	225	878	891	890	886	883
Ash	85	28	73	69	70	70
Crude protein	164	138	352	344	363	356
Ether extract	54	23	84	110	106	114
Crude fibre	301	51	130	134	120	125
Nitrogen free extracts	402	762	362	345	343	336
Glucosinolates, µmol/g fat free meal			30.3	12.7	21.9	15.4
FU/kg DM	0.72	1.13	1.05	1.10	1.10	1.11
ME, MJ/kg DM	10.1	13.3	12.4	12.9	12.9	13.1
DCP, g/kg DM	115	94	292	285	301	296

Table 2. Feed dry matter (DM) intake (kg/d) and intake of digestible crude protein (DCP, g/d) and metabolizable energy (ME, MJ/d)

Treatment	A	B	C	D	E	SEM
Concentrate						
Period 1	1.78	1.82	1.81	1.81	1.81	0.015
Period 2	2.97	3.02	3.00	2.97	2.96	0.035
Periods 1+2	2.38	2.42	2.41	2.39	2.39	0.022
Roughage						
Period 1	3.26	3.20	3.38	3.44	3.33	0.099
Period 2	4.12	3.94	4.68	4.41	4.56	0.147
Periods 1+2	3.69	3.57	4.03	3.92	3.95	0.108
Total						
Period 1	5.04	5.02	5.19	5.24	5.14	0.101
Period 2	7.09	6.96	7.68	7.37	7.52	0.151
Periods 1+2	6.24	6.14	6.58	6.45	6.48	0.110
DCP						
Period 1	575	650	677	704	669	15.7
Period 2	761	830	903	873	897	16.5
Periods 1+2	663	740	784	776	777	12.4
ME						
Period 1	57.5	56.1	58.0	58.6	57.6	1.03
Period 2	81.9	79.3	86.8	83.6	85.2	1.55
Periods 1+2	69.7	67.7	72.4	71.1	71.4	1.12

Table 3. Live weight (LW), live weight gain (LWG), slaughter characteristics and feed conversion

Treatment	A	B	C	D	E	SEM
LW, kg						
Initial	104.7	100.2	108.3	104.6	110.2	2.80
20 weeks	259.7	256.5	275.9	272.0	271.4	5.31
40 weeks	422.1	410.4	447.8	438.0	439.7	8.32
LWG, g/d						
Period 1	1107	1116	1197	1196	1151	27.7
Period 2	1160	1099	1228	1186	1203	35.3
Periods 1+2	1133	1108	1212	1191	1177	25.9
Carcass weight, kg	215.8	210.9	231.0	229.2	229.3	4.48
Dressing %	51.3	51.5	51.6	52.2	52.1	0.38
Quality grade(1)	8.3	8.1	8.2	8.7	8.6	0.15
Fatness grade(2)	1.2	1.2	1.3	1.2	1.4	0.15
Feed conversion						
MJ ME/kg LWG	61.5	61.4	59.8	59.8	60.9	0.96

(1) 10 = best quality, (2) 1 = leanest.

DISCUSSION

Chemical Composition

In accordance with the decrease in rumen degradability of protein (see Vanhatalo and Aronen 1991) the content of glucosinolates in the two heat-moisture treated RSMs was lower than in the untreated ones the difference being more distinct between RSM-1 and RSM-2 than between RSM-3 and RSM-4. The effect of heat treatment on glucosinolate content of RSM and on myrosinase activity has been described by e.g. Bille et al. (1983).

Feed Intake

In period 1 the concentrates containing RSM were more palatable than barley alone. This observation is in accordance with results reported by Aronen (1991) but opposes those reported earlier by Aronen (1990). The differences in processing methods and varieties may explain these opposite findings. The effect of variety was clearly demonstrated by Schwarz and Kirchgessner (1989), who observed decreased concentrate intake with a 0-variety as compared with a 00-variety.

The differences in voluntary grass silage intake between the treatments, being nonsignificant in period 1, were significant in period 2. RSM supplementation in general (effect 1) tended ($P<0.10$) to have a positive effect on grass silage intake. Especially the heat-moisture treatment seemed to increase it ($P<0.05$). However, this positive effect was found only between the RSM-2 and RSM-1 (the interaction between variety and heat-moisture treatment tended ($P<0.10$) to be significant). Thus, the rumen degradability of RSM protein was not closely related to silage intake and some other factors may have been involved.

Lower content of glucosinolates in RSM-1 than in RSM-2 may explain the difference in grass silage intake between these two treatments. Also, in RSM-3, which was the other untreated RSM, the content of glucosinolates was clearly lower than in RSM-1. The metabolism of glucosinolates in the rumen has not been very intensively studied. However, it has been shown, that the degradation of glucosinolates in the rumen is rapid. Approximately 90 % of them were degraded after 60 minutes incubation in the rumen fluid (Kärnell 1988). In the present experiment the rumen-undegraded residue (10 h rumen incubation) of each RSM contained less than 0.1 µmol glucosinolates/g fresh sample.

Theoretically, it is possible, that the high content of glucosinolates or their hydrolysis end-products of RSM-1 in diet B had a negative influence on rumen microbes and thereby also grass silage intake. However, no supportive evidence for this theory can be found in the literature. Instead, the palatability problems are usually related to disorders of general metabolism (like hypothyroidism) caused by glucosinolates or their hydrolysis end-products (Vermorel et al. 1987).

One reason for the positive effect on grass silage intake of 00-RSMs may have been the supply of preformed amino-acids or peptides to rumen microbes (Oldham 1984). However, the positive effects of amino-acids or peptides on rumen microbes and hence, on feed intake have been usually (e.g. Ortiques et al. 1989) but not always (Hunt et al. 1989) followed by enhancement in diet digestion, which was not the case in this study (data not shown).

As suggested by e.g. Hunt et al. (1989) protein supplementation may affect silage intake also through an increase in the flow of dietary protein to the intestines. If this had been the case in the present experiment, there should have been an increase in grass silage intake also on diet B, where RSM-1 was included in the diet. The absence of a difference between treatments D and E does not support the theory, either.

Animal Performance

In terms of DCP the protein supply of diet A exceeded the Finnish requirements (Salo et al. 1990) throughout the experiment the excess being, on an average, 21 % in period 1 and 37 % in period 2. With the other diets the excess was much larger. Despite the ample supply of protein in diet A, the RSM supplementation tended to have a positive effect on LWG in period 1. In period 2 the effect was most pronounced with the 00-varieties. Calculated for the total experimental period, the significant interaction in LWG between variety and heat-moisture treatment, together with tendency of improved gain with the heat-moisture treated RSMs, support an assumption, that other factors than rumen degradability of RSM per se have been involved. Indeed, in those diets, which showed improved gain (diets C, D and E), increased grass silage intake, and thereby also enhanced energy intake was recorded.

The differences in fatty acid composition (data not shown) in subcutaneous and m. longissimus dorsi fat between the feeding groups fed different RSMs indicate, that the quality of meat can be influenced by rapeseed variety and RSM processing method. Therefore research in that area should be intensified.

CONCLUSIONS

The improved animal performance in this experiment could not be explained solely by the reduced rumen degradability and increased supply of rumen-undegraded feed protein to intestine. Instead, the enhanced LWG of 00-RSM supplemented bulls was closely related to increased grass silage intake and thereby increased energy intake. Heat-moisture treatment of RSM effectively reduced the content of glucosinolates, which was favourable for voluntary grass silage intake.

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