Rapeseed expeller is a better protein supplement than soybean expeller in dairy cow diets based on grass-clover silage

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Introduction Soybean based feeds are widely used as protein supplements for dairy cows, but rapeseed provides an alternative source of high quality plant protein into ruminant diets. There is increasing evidence that rapeseed based feeds are excellent protein supplements for dairy cows fed grass silage based diets (Huhtanen et al. 2011). Our objective was to evaluate the dairy cow responses particularly in N metabolism to increasing levels of rapeseed and soybean expellers. The diet characteristics (expeller rather than meal, 0.5 red clover in the silage on dry matter (DM) basis and concentrate proportion 0.36 of DM intake) were chosen to agree with requirements set for organic milk production.

Material and methods The experiment was conducted at MTT Agrifood Research Finland according to an incomplete 5×4 Latin Square design using five ruminally cannulated Finnish Ayrshire cows and four experimental periods of 21 d each. The rapeseed expeller (RSE) and soybean expeller (SBE) were produced by Mildola Ltd. (Kirkkonummi, Finland) with crude protein (CP) concentrations of 371 and 480 g/kg DM and ether extract concentrations of 94 and 76 g/kg DM, respectively. They were fed at two isonitrogenous levels (Table 1), and replaced the basal concentrate which was a 1:1 mixture of pelleted barley and oats. The amount of concentrate fed was 9 kg/d for all diets. The basal silage was a 1:1 mixture of pure red clover silage and pure grass silage. The in vitro digestible organic matter (OM) concentration (D-value) of the silage mixture was 668 g/kg DM and the CP and neutral detergent fibre concentrations were 157 and 498 g/kg DM, respectively. Both parent silages had rather low DM concentrations (198 and 262 g/kg for red clover and grass, respectively) but they were prepared using formic acid based additives and were well preserved [pH 3.79 and 4.20 and ammonia N in total N 48 and 54 g/kg for red clover and grass, respectively].

Standard feed intake and milk production records were taken. The flow of nutrients to omasum was measured using omasal sampling over four days and triple-marker method. Diet digestibility was measured by conducting total faecal collection during 4 days. Blood samples were taken from the tail vain at 0, 3 and 6 h after the morning feeding on the last day of each period. For more details regarding the experimental procedures and analytical methods, see Vanhatalo et al. (2009). The feed values were calculated according to MTT (2011). The results were calculated using SAS GLM by including the effects of period, cow and diet in the model. The effect of diet was split into effects of RSE *vs.* SBE, linear effect of protein supplementation and their interaction by using contrasts.

Results and discussion Increasing protein supplementation increased linearly DM, energy and protein intake, supply of N to the omasum, and milk production (Table 1). The increase in milk production was greater when RSE rather than SBE was fed. Protein supplementation also increased diet OM and CP digestibility, and the increase was greater when SBE rather than RSE was fed. The true protein digestibility calculated using the Lucas equation was 0.848 for RSE and 0.955 for SBE. The effective degradability of rapeseed and soybean expeller protein in the rumen is 0.60 and 0.75 (MTT 2011), respectively, resulting in metabolizable protein (MP) values of 174 and 167 g/kg DM for them. When the protein efficiency was expressed as regression between CP intake and milk protein output, RSM was superior compared to SBE (slopes 102 vs. 55). When MP was used as input, the difference declined (slopes 0.297 vs. 0.230) showing that Finnish MP was rather good in predicting the production responses of these two protein supplements.

The N or individual AA (data not shown) flows to the omasum did not differ between the supplements, and the differences in the plasma AA concentrations were minor. There was however a tendency for a lower plasma methionine concentration on SBE diets compared to RSE diets.

Conclusions The N use efficiency was higher when RSE based diets compared to the SBE diets were fed, but increasing the level of protein intake from both supplements decreased the N use efficiency. Although protein supplementation elicited significant milk production responses, the level of milk production was rather high even when the control diet was fed.

References

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Table 1. Feed and nutrient intake, milk production, diet digestion and plasma amino acid concentrations of dairy cows supplemented with rapeseed or soybean expeller.

	Control	Rapeseed exp.		Soybean exp.		SEM	Stat. signific.[1]		
		Low	High	Low	High		RvsS	Lin	1×L
Feed and nutrient intake per									
Dry matter (DM, kg)	19.6	21.4	21.7	20.3	20.7	0.45	*	*	
Silage (kg DM)	12.7	13.3	13.6	12.3	13	0.38	o		
Protein suppl. (kg DM)	0	1.78	3.34	1.34	2.51	---			
Crude protein (kg)	2.89	3.62	4.15	3.47	4.07	0.064		***	
Metab. energy (MJ)	221	242	245	233	239	5.5		*	
Metab. protein (g)	1735	2061	2245	1907	2053	41.2	**	***	*
N flow to omasum (g/d)	549	625	662	617	631	17.6		***	
Milk production									
Milk (kg/day)	32.7	35.3	35.8	33.7	34.1	0.91		o	*
ECM[2] (kg/day)	31.1	34.0	34.5	32.2	32.4	0.57	**	*	*
Fat (g/kg)	37.6	37.7	38.2	38.0	37.0	1.59			
Protein (g/kg)	29.8	30.9	30.7	29.5	30.4	0.48			
Urea (mg/100 ml)	18.1	25.8	29.9	26.1	34.0	1.91		***	
Diet digestibility from total faecal collection									
Organic matter	0.710	0.708	0.712	0.727	0.733	0.0046	**	o	*
Crude protein	0.618	0.642	0.672	0.663	0.704	0.0076	**	***	*
Amino acid (AA) concentration in plasma (µmol/l)									
Methionine	15.3	15.9	18.8	17.3	12.5	1.16	o		**
Histidine	34.9	44.2	46.9	45.5	45.4	2.89		*	
Branched-chain AA	598	723	801	709	778	69.9		o	
Essential AA	974	1135	1247	1157	1163	93.5		o	
Non-essential AA	1112	1107	1139	1165	974	34.4			**
Total AA	2087	2242	2385	2321	2137	124.6			

[1]RvsL = Rapeseed expeller vs. soybean expeller, Lin = linear effect of protein supplementation, 1×L = interaction between protein source and Lin [2]Energy corrected milk