

The effect of rapeseed oil on the ruminal degradability and intestinal protein digestibility of rapeseed meal, soyabean and lupin seed

W. Nowak¹ and S. Wylegała

*The August Cieszkowski Agricultural University of Poznań,
Department of Animal Nutrition and Feed Management
Wołyńska 33, 60-637 Poznań, Poland*

ABSTRACT

Three rumen and proximal duodenum cannulated Jersey heifers were used in a 2×3×3 Latin square design experiment to determine the effect of rapeseed oil supplementation on ruminal and intestinal protein digestibility of rapeseed meal, soyabean meal and lupin seed. Rapeseed oil at 0, 100, 200, 300, 400, 500 g/day was infused into the rumen cannula. The ruminal degradation of protein was estimated by using rumen nylon bags (*in sacco* method), the intestinal digestibility of rumen undegraded protein, by the mobile nylon bag method. A high level of rapeseed oil (400 and 500 g) significantly decreased effective degradability and increased intestinal digestibility of rapeseed meal and lupin seeds. Lower levels of oil (100, 200, 300 g) did not significantly affect protein degradation in the rumen or intestinal digestibility.

KEY WORDS: fat, rumen protein degradation, intestinal digestibility

INTRODUCTION

The use of supplemental oils in the diets of high-yielding ruminants has become a standard practice (Drackley, 1999). Extensive research has been conducted to evaluate the effects of fats on carbohydrate metabolism in the rumen. Fats may decrease the degradability of structural carbohydrates in the rumen. Much less research is available concerning the relationship between fat and protein in the rumen. Protein evaluation systems assume that protein requirements for ruminants are met from microbial protein and dietary protein digested (UDP) in the small intestine. UDP can be supplied by reducing ruminal degradation and increasing the amount of protein digested postruminally (Mustafa et al., 2000).

¹ Corresponding author: e-mail: nowakwl@jay.au.poznan.pl

The objective of the study was to estimate the effect of rapeseed oil administered *via* a rumen cannula on protein degradability and intestinal digestibility of rapeseed meal, soyabean meal and white lupin seed.

MATERIAL AND METHODS

Three Jersey heifers weighing 420 kg fitted with ruminal and proximal duodenal cannulas were used in a two 3×3 Latin square design experiment. The daily amount of rapeseed oil 0 (RSO-0), 100 (RSO-100), 200 (RSO-200), 300 (RSO-300), 400 (RSO-400) or 500 g (RSO-500) was split into two equal parts and administered into the rumen by a cannula at 7 a.m. and 7 p.m.

Heifers were fed hay *ad libitum*. Individual daily dry matter intake was measured. Each feeding cycle consisted of 21 days of which 14 days were treated as an adaptation phase followed by a 7-day trial period to perform the nylon bag procedure. Quadruplicate nylon bags were incubated for 0, 2, 4, 8, 12, 16, 24 and 48 h in the rumen for measuring protein degradability of rapeseed meal (RSM), soyabean meal (SBM) and white lupin seeds (LS).

The percentages of DM and CP degraded at each incubation time were calculated and the rate of degradation was estimated using non-linear regression (Ørskov and Mc Donald, 1979). Three constants were used to calculate effective degradability (dg) according to the equation $dg = a + (bc)/(c+k)$.

Four extra sample bags were incubated for 12 h to determine protein digestibility using mobile bags. Intestinal digestibility of protein undegraded in the rumen was measured by the mobile bag technique (Madsen et al., 1995).

Data were analysed in a 3×3 Latin square design using the procedure of general models: $Y_{ijk} = M + C_i + P_j + T_k + E_{ijk}$, where Y_{ijk} = observation, P_j = period effect, T_k = treatment effect E_{ijk} = random error, M = overall mean, C_i = cow effect. Effects were considered significant at $P < 0.05$.

RESULTS

There was a tendency towards decreasing average dry matter intake in diets RS-400 and RS-500 but the differences were not significant ($P < 0.05$) (Table 1). Effective protein degradability (EPD) of RSM and LS was significantly ($P < 0.05$) decreased by infusion into the rumen of 400 and 500 g of rapeseed oil (Table 2). The highest level of oil instantly decreased the degradable fraction (a) of RSM and LS by 6.05 and 17.80%, respectively. Lower rumen degradation was followed by increasing intestinal digestibility of undegraded protein (DUP). A high level of oil shifted the digestibility of protein partly from the rumen to the intestine.

Table 1. Effective protein degradability, constants of degradation and intestinal digestibility of undegraded protein

	Rapeseed oil administered into the rumen, g/day					
	0	100	200	300	400	500
Dry matter intake, kg	6.31	6.60	6.34	6.12	5.81	5.65
Oil, % DM	0	1.51	3.15	4.90	6.88	8.85
Rapeseed meal						
fraction <i>a</i> ,%	13.10	12.90	11.89	12.20	7.70*	7.05*
fraction <i>b</i> ,%	79.20	78.30	79.40	80.37	83.40	84.20
<i>c</i> , % h ⁻¹	0.240	0.251	0.245	0.251	0.187*	0.190*
EPD %	76.70	76.08	75.67	77.06	70.84*	71.04*
DUP %	65.66	64.80	61.30	63.20	68.20*	70.12*
Soyabean meal						
fraction <i>a</i> ,%	10.56	12.47	9.30	10.34	9.45	8.99
fraction <i>b</i> ,%	82.32	80.34	84.20	85.30	82.09	85.56
<i>c</i> , % h ⁻¹	0.102	0.098	0.111	0.090	0.110	0.123
EPD %	62.39	62.30	67.12	61.52	62.57	66.50
DUP %	74.19	77.30	75.00	71.51	73.29	76.20
White lupin seed meal						
fraction <i>a</i> ,%	65.10	66.27	70.20	65.30	51.30*	47.30*
fraction <i>b</i> ,%	27.30	28.40	25.30	29.20	41.20*	40.45*
<i>c</i> , % h ⁻¹	0.200	0.213	0.217	0.197	0.176*	0.157*
EPD %	86.10	88.43	90.02	87.68	82.03*	76.56**
DUP %	63.20	64.29	60.02	62.05	65.19	66.40

*, ** means in the same row followed by different letters differ significantly ($P < 0.05$)

a = instantly degradable fraction; *b* = slowly degradable fraction; *c* = rate of degradation

EPD = effective protein degradability; DUP = digestibility of rumen undegraded protein

DISCUSSION

Similarly to our results, Jenkins (1990) reported that infusion of linseed oil, maize oil and lecithin into the rumen reduces ruminal protein degradability. In many studies unprotected fat lowered the ammonia concentration in the rumen. Kim et al. (1993) suggested that this reduction may indicate inhibition of microbial proteolytic activity or more efficient utilization of ammonia N for ruminal microbial synthesis. Drackley and Elliot (1993) found a linear increase in total crude protein digestibility as the amount of partially hydrogenated tallow in the diet was increased. There was no significant effect of rapeseed oil on degradability coefficients or intestinal digestibility of undegraded protein (DUP) of SBM. In similar studies on cannulated cows, Ben Salem et al. (1993) found no significant effect of 7% oil supplementation on EPD. Similarly, Broudiscou et al. (1990) observed no effect of soya hydrolysate fat on protein degradability in the rumen.

CONCLUSIONS

Our study demonstrates that high levels (6.9 and 8.8% DMI) of unprotected fat may shift the digestibility of easily degradable protein feeds from the rumen to the intestine.

REFERENCES

- Ben Salem H., Krzeminski R., Ferlay A., Doreau M., 1993. Effect of lipid supply on in vivo digestion in cows. Comparison of hay and corn silage diets. *Can. J. Anim. Sci.* 73, 547-557
- Broudicou L., Van Nevel C.J., Demeyer D.I., 1990. Effect of soy oil hydrolysate on rumen digestion in defaunated and refaunated sheep. *Anim. Feed Sci. Tech.* 30, 51-67
- Drackley J.K., 1999. Biology of dairy cows during the transition period: the final frontier? *J. Dairy Sci.* 82, 2259-2273
- Drackley J.K., Elliot J.P., 1993. Milk composition, ruminal characteristics and nutrient utilization in dairy cows fed partially hydrogenated tallow. *J. Dairy Sci.* 76, 183-196
- Jenkins T.C., 1990. Nutrient digestion, ruminal formulation, and plasma lipids in steer fed combinations of hydrogenated fat and lecithin. *J. Dairy Sci.* 73, 2935-2939
- Kim Y.K., Shingoethe J., Casper D.P., Ludens F.C., 1993. Supplemental dietary fat from extruded soybeans and calcium soap of fatty acids for lactating dairy cows. *J. Dairy Sci.* 76, 197-204
- Madsen J., Hvelplund T., Weisbjerg M.R., Bertilsson J., Olsson I., Spörndly R., Harstad O.M., Volden H., Tuori M., Varvikko T., Huhtanen P., Olafsson B.L., 1995. The AAT/PBV protein evaluation system for ruminants. A revision. *Norwegian J. Agr. Sci., Suppl.* 19, 2-37
- Mustafa A.F., McKinnon J.J., Christensen D.A., 2000. Protection of canola (low glucosinolate rapeseed) meal and seed protein from ruminal degradation. *Review. Asian-Austr. J. Anim. Sci.* 13, 535-542
- Ørskov E.R., McDonald I., 1979. The estimation of protein degradability in the rumen from incubation measurements weighted according to rate of passage. *J. Agr. Sci.* 92, 499-502

STRESZCZENIE

Wpływ oleju rzepakowego na rozkład w żwaczu i strawność jelitową białka poekstrakcyjnych śrut rzepakowej, sojowej oraz nasion łubinu

Określono metodami *in sacco* i woreczków mobilnych wpływ oleju rzepakowego na rozkład w żwaczu białka poekstrakcyjnej śruty rzepakowej, sojowej i nasion łubinu. Badania przeprowadzono na jałówkach rasy Jersey z trwałymi przetokami żwaczowymi i dwunastniczymi w układzie dwóch kwadratów łacińskich. Olej rzepakowy 0, 100, 200, 300, 400, 500 g/dzień wprowadzano bezpośrednio do żwacza przez kaniulę.

Duże dawki oleju (400 i 500 g) spowodowały zmniejszenie efektywnego rozkładu białka poekstrakcyjnej śruty rzepakowej i ziarna łubinu przy jednoczesnej poprawie strawności jelitowej.