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Effect of Diet Containing a Variety of Iranian Rapeseed Meal (SLM sp.) on High Producing Lactating Holstein Cow Responses

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Abstract: *In situ* degradable parameters and ruminal and post ruminal disappearances of Dry Matter (DM) and Crude Protein (CP) of a variety of Iranian rapeseed meal (SLM sp.) were determined. Then, 14 early lactating Holstein cows for 8 weeks were fed diets containing 10.95% Soybean Meal (SBM) or 10.85% Rapeseed Meal (RSM) in a completely randomized design with repeat measurement analysis. Dry matter intake and milk yield were measured daily and milk composition were measured weekly. Blood metabolites including glucose and non amino-N were measured in weeks 1, 4, 6 and 8. Feces pH was monitored at weeks 4 and 8. Degradable coefficients of RSM including rapidly, slowly and Fractional degradation rate, were 0.32, 0.49 and 0.092 for DM and 0.33, 0.58 and 0.12 for CP, respectively. Ruminal and post ruminal disappearance of DM and CP were 0.68, 0.52 and 0.71 and 0.66, respectively. Dry matter intake (kg/cow/day) was significantly ($p<0.05$) influenced by the diets (RSM = 19.9, SBM = 20.5, SEM = 0.21). Milk protein and milk solid non-fat of cows fed RSM (28.88 and 86.03, respectively) were significantly higher ($p<0.05$) compared with animals fed SBM (27.63 and 81.8, respectively). Milk fat, lactose and urea nitrogen, fecal pH and BCS were all similar between diets ($p>0.05$). Data of the present experiment indicated that the Iranian variety of RSM might be used in high producing lactating Holstein cows without any adverse effect.

Key words: Rapeseed meal, soybean meal, crude protein, degradability, coefficients, ruminal and post ruminal disappearances

INTRODUCTION

Rapeseed Meal (RSM) is becoming an increasingly important source of protein for ruminants and non-ruminants. The inclusion of early varieties of RSM in dairy cow rations, due to the high level of glucosinolates, had been limited, but new varieties, low in glucosinolate and erusic acid, have been approved and are expected to replace other protein feed source like Soybean Meal (SBM). Several experiments have been conducted on the value of RSM for dairy cows (Laarveld and Cheristensen, 1976; Sanches and Claypool, 1983). The crude protein content of RSM is almost high and major mineral concentrations like Ca, P and Mg are almost twice compared with SBM. Rapeseed meal is an excellent source of histidine, methionine, cysteine and threonine with the best amino acid balance (Laarrveld and Cheristensen, 1976). Despite its excellent amino acid balance and milk production response, rapeseed meal might improve the dairy cow responses by enabling more of the protein, especially the essential amino acids, to bypass the rumen. *In situ* degradable coefficients of DM and CP of RSM have been reported by some workers (Khorasani *et al*., 1993; Robinson *et al*., 1993). In some studies, inclusion of RSM instead of the other protein sources such as soybean meal in dairy cow diets caused to increase milk production and it was not reported any unpleasant effect on dry matter intake, milk production and reproduction (Emanuelson *et al*., 1993). Therefore, it seems that rapeseed meal with high protein and low glucosinolate and fiber contents might be a good substitute for other protein sources. The objectives of the present study, was to determine the chemical composition, *in situ* degradable coefficients and ruminal and post-ruminal dry matter and protein disappearances of an Iranian variety of rapeseed meal (SLM sp.) and to evaluate the effect of inclusion of RSM instead of SBM in a diet on the responses of high producing lactating Holstien cows.

MATERIALS AND METHODS

***In situ* procedure:** Ten samples of RSM (SLM sp.) were collected from different regions of Iran. Then, samples were composited and sub-samples were taken from each composite. Samples were dried using a forced-air oven at 96°C for 48 h. All samples were ground to pass through a

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2-mm screen. Chemical composition (CP, Ether extract, NDF, ADF, Ca, P) was determined using the standard procedure of AOAC (1990). DM and protein degradable fractions of the Iranian rapeseed meal variety of (SLM sp.) were determined using *in situ* technique in 4 rumen fistulated and intestinal canulated Holstein steers (400±12 kg, body weight). Animals were fed a 60:40 concentrate to forage diet. Samples were weighed (6 g DM) into polyester cloth bags (12×19 cm) with 52 μm pore size. Bags were incubated in the rumen for 0.0, 2, 4, 8, 16, 24, 48 and 72 h (Mohammadabadi *et al*., 2008). The ruminal and post ruminal disappearances of DM and CP of samples were determined using the mobile nylon bag procedure (Danesh and Stern, 2005). Samples were weighed (1g DM) into polyester cloth bags (3×6 cm) with 50 μm pore size (12 bags per each sample). Bags were incubated in the rumen for 12 h. After removing from the rumen, 6 bags were washed using cold water and dried in a forced-air oven (58°C, 48 h) to determine rumen disappearance and other bags were inserted into the small intestine via the cannulae at the rate of one bag every 30 min and removed from the voided faeces, rinsed in cold water. Finally, the bags were dried in a forced air oven (58°C, 24 h) and then, weighted to determine the dry matter disappearance. All non and incubated samples were applied to kjeldhal technique (Kjeltec 2300 Autoanalyzer, Foss Tecator AB, Hoganas, Sweden) to determine nitrogen concentaration.

Feeding trail: Fourteen multiparous and primiparous lactating Holstein cows averaging 49±13.21 Days in Milk (DIM) were assigned in a completely randomized design with repeat measurement analysis. The animals were housed in a tie-stall barn and given *ad libitum* a total mixed ration for 8 weeks. Experimental diets were provided (Table 1) to meet the requirement of high producing cows. The diets were prepared to include SBM or RSM as protein sources (Table 1). Dry matter intake and milk production were recorded daily. Cows were milked at 04:00, 12:00 and 20:00 h. Milk samples were taken at each milking, once a week and mixed according to the yields to get a sample per each cow. Blood samples were collected into heparinized tubes from the jugular vein of each cow at 0.0, 3 and 6 h after morning feeding on day 7, 28, 42 and 56. Samples were immediately centrifuged at 3000 RPM for 10 min to prepare plasma as supernatant. Body Condition Score (BCS) was determined at the first and last weeks of the experimental period. Milk composition was determined by Milko-Tester (Foss Electric, Conveyor 4000). Milk Urea Nitrogen (MUN) was determined using enzymatic procedure (Zistchimi, Tehran, Iran). Plasma samples were analyzed for non-amino nitrogen and glucose concentration using spectrophotometer procedure (zistchimi, Tehran, Iran).

Table 1: Composition of the experimental diets

	Experimental diets	
Component	SBM	RSM
Alfalfa hay	24.39	24.41
Corn silage	12.36	12.37
Oats grain	11.39	11.39
Corn grain	13.51	13.51
Cotton seed	10.58	10.58
Soybean meal	10.95	1.41
Rapeseed meal	0.00	10.85
Wheat bran	8.28	6.91
Beet pulp	7.02	7.02
Limestone	0.14	0.14
Dicalcium phosphate	0.18	0.18
Min and vit premix	0.71	0.71
Sodium bicarbonate	0.48	0.48
CP	16.00	16.00
ME (MJ kg^{-1})	11.80	11.80
NFC	29.00	29.00
NDF	34.30	34.30
ADF	17.50	17.50
Calcium	0.64	0.68
Phosphorus	0.45	0.49

SBM: Diet containing 10.95% Soybean Meal; RSM: Diet containing 10.85% Rapeseed Meal

Calculation and statistical procedures: The degradable parameters of DM and CP were determined using the equation:

$$P = a+b\ (1 - e^{-ct})$$

where:

a = Rapidly degradable fraction
b = Slowly degradable fraction
c = Fractional degradation rate
t = Incubation time

Ruminal and post ruminal disappearances were calculated as proposed by Danesh and Stern (2005).

Milk yield and composition, plasma glucose and non ammonia-N were statistically analyzed using a mixed procedure of SAS (SAS Inst. Inc., Cary, NC) using the following model:

$$Y_{ijk} = \mu + T_i + A_{ij} + D_k + (T\times D)_{ik} + \varepsilon_{ijk}$$

where:

Y_{ijk} = Dependent variable
μ = Overall mean
T_i = Treatment effects
A_{ij} = Random effects of animal within treatments
D_k = Effects of sampling day or time
$(T\times D)_{ik}$ = Interaction effects of treatment and sampling day or time
ε_{ijk} = Residual error associated with the ijk observation

Data of fecal pH and BCS were analyzed using completely randomized design model of SAS.

RESULTS AND DISCUSSION

***In situ* procedure:** Chemical composition of RSM is shown in Table 2. These results confirmed the finding of Emanuelson *et al.* (1993). Degradable coefficients, ruminal and post-ruminal disappearance of DM and CP of rapeseed meal are shown in Table 3. Present data of total tract DM and CP disappearances of RSM measured by mobile bag were very close to SBM data reported by Danesh and Stern (2005). Present results confirmed previous data which showed that the post ruminal disappearance of CP of RSM was 0.67.

Feeding trial: Dry matter intake (Table 4) was affected by the diets ($p<0.05$). Cows had lower dry matter intake when fed RSM compared with those of SBM. Present data confirmed previous findings of Fisher and Walsh (1976) which indicated RSM caused to decrease DM intake. Milk production was not affected by the experimental diet. Milk fat content was higher in cows fed RSM, but not significantly. Kokkonen (2000) showed an increase in milk fat using RSM which is probably due to large amount of fiber in RSM (15.2% DM) compared with SBM. Milk protein was significantly increased in cows fed RSM ($p<0.05$). Our results are in consistent with pervious research (Kokkonen *et al*., 2000). Pervious study has reported a result of positive relation between diet containing of RSM and milk protein percentage (Emanuelson *et al*., 1993). Rapeseed meal is an excellent source of histidine, methionine, cysteine and threonine. Because of the best amino acid balance and digestibility, this protein source can be used as a good source of protein in ruminants (Danesh and Stern, 2005). In the present study, milk lactose content was similar among diets. This result is in agreement with those obtained by Kokkonen *et al*. (2000). The starch content of RSM was 14.7% which was higher than SBM (12.5%). Starch might increase ruminal propionate production that is the most important precursor of glucose in ruminants which enhances milk lactose production. Solid not fat content of milk was increased significantly for diet containing rapeseed meal ($p<0.05$) which is in consistent with other reports (Khorasani *et al*., 1993; Robinson *et al*., 1993). Milk Urea Nitrogen (MUN) was higher numerically in cows fed SBM but the difference was not significant ($p = 0.56$). MUN concentration is related to dietary CP intake, the percentage of rumen degradable and undegradable protein as well as protein-energy ration in the diet (Rajala and Savilk, 2003). When protein degradability in the rumen or protein concentration of a diet is higher, ammonia production in the rumen and its convert to urea in liver will be increased that lead to increase in blood and milk urea. On the other hand, increase in carbohydrate content of a diet lead to increase in microbial growth and decrease in rumen ammonia and blood and milk urea nitrogen concentrations (Mabjeesh *et al*., 1997). Results of the present experiment of blood metabolite concentrations have been shown in Table 5. There was no significant effect on blood glucose, but it was numerically higher for SBM than RSM. Increase in protein intake, causes to enhancement of protein catabolism and gluconeogenesis, which converts amino acids to glucose, by then plasma glucose would be increased. Similarly, dietary treatment had no significant effect on non-amino Nitrogen concentration in the blood. Data of fecal pH and body condition score are shown in Table 6. Fecal pH was similar among the diets. Fecal pH was in the range of 6.1-7. Fermentable carbohydrates are the most important factor affecting fecal pH. High amounts of fermentable carbohydrates in diet resulted in high amount of volatile fatty acids in feces which decreased fecal pH (Bodine *et al*., 2001). Fecal pH in the present study is similar to that reported by Bodine *et al*. (2001). Body condition score was not affected by diets which is in agreement with other studies (Fisher and Walsh, 1976; Sanches and Claypool, 1983).

Table 2: Chemical composition of rapeseed meal (SLM sp.) (DM%)

Item	Mean ± SD
Crude protein	41.60±0.34
Crude fat	1.1±0.2
NDF	27.3±1.40
ADF	19.4±2.15
Ash	8±0.26
Calcium	0.6±0.07
Phosphorus	1.02±0.11

Table 3: *In situ* degradable coefficients and ruminal and post-ruminal disappearance DM and CP of rapeseed meal, SLM sp. (mean ± SD)

Item	Dry matter	Crude protein
Rapidly degradable fraction (a)	0.324±0.015	0.334±0.019
Slowly degradable fraction (b)	0.491±0.018	0.576±0.022
Fractional degradation rate (c)	0.092±0.009	0.124±0.012
Ruminal disappearance	0.68	0.71
Post-ruminal disappearance of ruminal undegradable	0.52	0.66
Total tract disappearance	0.83	0.91

Table 4: Lactating Holstein cow responses to the experimental diets containing rapeseed meal or soybean meal

Items	SBM[a]	RSM[b]	SEM[c]	p-value
DMI (Kg day^{-1})	20.5	19.9	0.21	0.03
Milk yield (Kg day^{-1})	38.0	37.9	0.41	0.91
Milk fat (g kg^{-1})	25.8	28.1	0.12	0.20
Milk protein (g kg^{-1})	27.6	28.9	0.03	0.01
Milk lactose (g kg^{-1})	45.3	47.4	0.08	0.1
Milk SNF (g kg^{-1})	81.8	86.2	0.12	0.03
Milk Urea Nitrogen (mg dL^{-1})	16.5	16.2	0.37	0.56

a): Diet containing 10.95% soybean meal; b): Diet containing 10.85% rapeseed meal; c): Standard error of mean

Table 5: Effect of diets containing rapeseed meal or soybean meal on Blood metabolites of lactating Holstein dairy cows

	Glucose				Non amino nitrogen			
Sampling time	SBM[a]	RSM[b]	SEM[c]	p-value	SBM	RSM	SEM[c]	p-value
Before feeding	62.53	61.23	1.3	0.1	18.33	18.28	0.9	0.07
Two hours after feeding	59.03	55.85	1.2	0.26	18.43	18.77	0.9	0.5
Four hours after feeding	61.6	60.33	2.3	0.8	18.35	18.34	1.1	0.6

a): Diet containing 10.95% soybean meal, b): Diet containing 10.85% rapeseed meal, c): Standard error of mean

Table 6: Effect of diet containing rapeseed meal or soybean meal on fecal pH and body condition score of lactating Holstein dairy cows

	Fecal pH				Body condition score			
	SBM[a]	RSM[b]	SEM[c]	p-value	SBM[a]	RSM[b]	SEM[c]	p-value
Middle period (28 d)	6.9	6.8	0.03	0.4	2.05	2.14	0.12	0.8
End of period (56 d)	6.9	6.9			2.24	2.24		

a): Diet containing 10.95% soybean meal, b): Diet containing 10.85% rapeseed meal, c): Standard error of mean

CONCLUSION

Rapeseed meal is a good protein source with high nutritional quality for dairy cows. The crude protein of rapeseed meal was almost high and comparable with other protein sources like soybean meal. Rapidly degradable fractions of RSM for DM and CP were low but slowly degradable fraction was high. The variety of RSM was used in the present study had a good ruminal and post-ruminal digestibility. Replacement of RSM for SBM had no negative effect on milk yield. Milk protein and SNF were increased using RSM. Fecal pH was similar among animals fed the experimental diets. It was concluded that the RSM had no negative effect on BCS compared with SBM. In addition, data of blood plasma metabolites indicated that there was no unfavorable effect of RSM on the animals used in the present experiment.

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