Effects of Processing Methods and Variety of Rapeseed Meal on Ruminal and Post Ruminal Amino Acids Digestibility

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ABSTRACT : The objective of this study was to determine the effects of processing method and rapeseed variety on ruminal and intestinal protein digestibility of rapeseed meal in steers. Intestinal amino acid digestibility was assessed with an *in situ* ruminal incubation and precision-fed rooster bioassay. In this experiment one traditional rapeseed meal sample (sample A, prepress extraction) and three double low rapeseed meal samples (sample B, prepress extraction, sample C, screw press and sample D, low temperature press) were placed in polyester bags(8 cm×12 cm) and suspended in the ventral rumen of steers for 16 h. The residues of *in situ* incubations were intubated to roosters. Total excreta were collected for 48 h after incubation and then desiccated and amino acid concentrations were determined. Results showed that in ruminal incubation the degradation rate of amino acid and crude protein was higher for traditional rapeseed meal sample A than for double low rapeseed meal sample B, but was much lower than for double low sample C and D. In the group of double low rapeseed meal samples, sample D processed by low temperature press had the highest degradation rate of amino acids in the rumen. For all amino acids, the digestibility of the residual protein as measured by the precision-fed rooster bioassay tended to be lower for sample B than for sample A, which had the same processing method with sample B, and in the group of double low rapeseed meals, sample B had similar digestibility of amino acid in residual protein to sample D and higher than that of sample C. However, although the total amino acid availability involving the digestibility of amino acids in the rumen and rooster bioassay of double low rapeseed meal sample D (low temperature press) was higher than those of the other three samples by 7 to 9 percent, there were no significant differences. Results indicated that processing method markedly affected ruminal and post ruminal amino acid digestibility of rapeseed meal when the temperature exceeded 110°C. Rapeseed meal that had a high content of fiber was not suitable for dry heat treatment at higher temperatures or the amino acids digestibility in rumen and total availability of amino acids could be reduced. Results also suggested the variety of rapeseed meal had no significant effect on the digestibility and availability of amino acids. ***(Asian-Aust. J. Anim. Sci. 2005. Vol 18, No. 6 : 802-806)***

Key Words : Rapeseed Meal, Amino Acid Availability, Bypass Protein

INTRODUCTION

Rapesees meal is a good source of feed especially for ruminant animals. There are three main kinds of rapeseed that processed by different methods: dark yellow powder (by prepress-extraction), brown slice (by screw press) and green slice (by low temperature press). The traditional processing method for rapeseed meal in China is the high temperature treatment and which is applied popularly.

However, the general processing methods, prepress-extraction and screw press for rapeseed heated at 110°C or higher than 120°C, respectively, so the excessive heat damage to the rapeseed protein and amino acids may be inevitable. Chen and Campbell (2003) evaluated the amino acid degradability of canola/rapeseed meal in rumen and the digestibility of amino acid in residual protein after ruminal incubation by precision-fed rooster bioassay, and reported that traditional process could decrease the degradability of amino acid in rumen but may decrease total availability of amino acids of rapeseed meal. Heat-damaged whole soybeans also caused a drop in the intestinal digestibility of essential and nonessential amino acids (Faldet and Satter, 1991).

The objective of this study was to evaluate the effect of different processing methods on the amino acids digestibility of rapeseed meal and also the effect of variety of rapeseed meal (one traditional rapeseed meal and three double low rapeseed meal).

MATERIALS AND METHODS

Rapeseed meal samples

One traditional rapeseed meal sample (sample A, prepress-extraction, 110°C, 60 min) and three double low rapeseed meal samples (sample B, prepress-extraction, 110°C, 60 min, sample C, screw press, higher than 120°C, 25-60 min and sample D, low temperature press, lower than 80°C) obtained from local crushing plants were used in the study.

Ruminal incubations

Two ruminally cannulated local steers fed a grass-corn diet were used for incubation of rapeseed meal samples. The diet contains 12% of rapeseed meal, and the content of

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Table 1. Amino acid content of rapeseed meal sample before and after 16 h rumen incubation (%) (dry matter base)

Amino acid	Traditional rapeseed meal				Double low rapeseed meal			
	Sample A		Sample B		Sample C		Sample D	
	Original	Residual	Original	Residual	Original	Residual	Original	Residual
Lysine	0.98	0.68	1.05	0.76	1.02	0.59	1.05	0.62
Methionine	0.53	0.43	0.60	0.46	0.64	0.30	0.64	0.30
Threonine	0.93	0.79	1.07	0.88	1.11	0.55	1.16	0.59
Isoleucine	0.74	0.65	0.86	0.74	0.88	0.44	0.87	0.45
Leucine	1.12	1.10	1.41	1.16	1.53	0.58	1.57	0.62
Phenylalanine	0.55	0.48	0.66	0.54	0.77	0.28	0.82	0.31
Histidine	0.38	0.27	0.42	0.29	0.41	0.20	0.43	0.21
Arginine	0.69	0.58	0.75	0.59	0.66	0.44	0.77	0.49
Valine	1.21	0.93	1.31	1.04	1.23	0.63	1.25	0.64
Tyrptophan	0.54	0.50	0.61	0.54	0.64	0.42	0.69	0.45
Aspartic acid	1.51	1.15	1.72	1.20	1.64	0.59	1.79	0.75
Serine	0.81	0.72	0.94	0.79	1.09	0.52	1.01	0.54
Glutamic acid	2.66	1.80	2.94	1.97	2.83	0.97	2.96	1.11
Glutamine	0.96	0.78	1.14	0.84	1.13	0.50	1.14	0.53
Alanine	0.84	0.81	0.97	0.83	1.07	0.41	1.17	0.44
Proline	1.29	0.78	1.61	0.93	1.44	0.64	1.44	0.73
∑AA	15.74	12.41[a]	18.01	13.51[a]	17.99	8.02[b]	18.76	8.75[b]

[a, b] Means within a row with different subscripts letters differ significantly ($p<0.05$).

total protein and energy is 17% and 13.22 MJ/kg, respectively. The ratio of feed to grass is 6:4. Two steers were pre-fed for 7 days and then for experiment.

Nylon bags (8 cm×12 cm, 50 μm porosity) containing 4 g rapeseed meal sample were incubated in the rumen for 16 h, and 24 bags were incubated each day in each steer for one sample (Feng, 1989). The whole experiment lasted 12 consecutive days according to the amount of residual samples that were obtained. After incubation, all the bags were washed for at least 20 minutes with cold tap water. After washing all bags were dried in a forced-air oven at 60°C for 48 h and retained for analysis as the residual meal sample. A composite residual sample was obtained for each rapeseed meal sample by combining 24 bags taken from each steer everyday.

Precision-fed rooster bioassay

Avian adult roosters (3.5 kg weight) were choosed to proceed this bioassay. The fomula feed was used and water was supplied constantly.

The precision-feeding TME technology of Sibbald (1987) was used to determine the digestibility of amino acid in residual samples. A diet containing 30 g residual samples was precision-fed to each of 8 birds per rapeseed meal sample. Endogenous amino acid losses were determined for birds by precision-feeding of 30 g non-nitrogen diet (4% carboxymethylcellulose and 96% starch). All assays were conducted using.

Chemical analyses

The original and residual rapeseed meal samples and the excreta were analyzed in duplicate for dry matter, crude protein(Kjeldahl N×6.25) and amino acids. Amino acids were determined by 835 HITACHI amino acid analyzer. NDF in samples were determined by method of Van Soest.

Statistical analysis of data

Statistical analysis of data was conducted with SPSS 11.0. The test of significance was carried out by One-Way ANOVA method.

RESULTS AND DISCUSSION

Amino acid content

The data in Table 1 shows the amino acid contents of original samples of rapeseed meal and residual samples after 16 h incubation in rumen. For all three double low rapeseed meals and to a lesser extent for the traditional rapeseed meal the amino acids content decreased in the residual samples. Related to the crude protein contents of the samples the amino acid contents was much higher for the traditional rapeseed meal sample than that of double low rapeseed meal samples. In double low rapeseed meal samples, the contents of amino acids in original sample B were similar to those of sample C and D but which had significantly lower ($p<0.05$) contents of amino acids in residual protein than those of sample B. All these data indicate the degradation rate of amino acid nitrogen in crude protein was higher than that of non amino acid nitrogen in crude protein, and the results also suggest that processing method has significant effect on the degradation of amino acid in ruminal incubation.

Rumen degradation of dry matter, crude protein and amino acids

The degradability in the rumen of traditional rapeseed

Table 2. Rumen degradability of individual amino acids for rapeseed meal samples following 16 h incubation (%) (dry matter base)

Amino acid	Traditional rapeseed meal	Double low rapeseed meal		
	Sample A	Sample B	Sample C	Sample D
Lys	71.31±0.10[a]	63.75±3.76[ab]	73.81±1.17[ac]	87.26±1.27[d]
Met	66.60±0.26[ad]	61.77±4.46[ab]	78.92±2.89[cd]	90.07±0.36[c]
Thr	64.84±1.42[a]	58.79±3.79[a]	77.37±1.25[b]	89.12±1.05[b]
Ile	63.42±2.10[a]	56.94±3.40[a]	77.41±1.72[b]	88.97±1.08[b]
Leu	59.10±2.81[a]	58.58±1.45[a]	88.82±1.67[b]	91.48±1.12[b]
Phe	63.65±1.37[a]	58.78±3.02[a]	83.39±0.91[b]	91.97±1.34[b]
His	75.95±1.53[ad]	65.79±3.61[a]	78.28±0.97[bd]	89.45±1.71[b]
Arg	64.99±1.67[a]	57.87±4.71[a]	69.56±1.27[a]	86.26±1.94[b]
Val	67.99±1.59[ad]	60.20±2.44[ab]	76.60±1.55[cd]	88.96±0.90[c]
Tyr	61.82±1.77[a]	55.78±5.33[ab]	75.37±2.34[ac]	86.09±1.36[c]
Asp	68.27±0.15[a]	64.82±4.14[a]	83.62±1.64[b]	90.96±1.02[b]
Ser	63.23±1.65[ad]	57.91±4.23[ab]	76.25±0.68[cd]	88.47±1.08[c]
Glu	71.89±1.06[a]	66.31±3.43[a]	84.33±1.42[b]	91.94±1.43[b]
Gly	66.16±1.16[a]	62.87±2.87[a]	79.79±1.19[b]	89.97±1.14[c]
Ala	60.09±2.07[a]	56.90±2.84[a]	82.75±1.39[b]	91.98±0.98[b]
Pro	74.97±0.26[ab]	75.89±2.39[a]	79.75±1.33[b]	89.06±1.26[cd]
Average	66.20[a]	61.12[a]	78.43[b]	89.50[b]
Dry matter	53.07±0.80[a]	43.34±1.13[b]	48.96±0.93[c]	76.22±0.65[d]
Crude protein	41.52±1.10[a]	44.55±0.37[b]	48.44±0.26[c]	81.02±0.21[d]

[a, b, c, d] Means within a row with different subscripts letters differ significantly ($p<0.05$).

Table 3. Amino acid digestibility for rumen residual samples of rapeseed meal as determined by the precision-fed rooster bioassay (%) (dry matter base)

Amino acid	Traditional rapeseed	Double low rapeseed		
	Sample A	Sample B	Sample C	Sample D
Lys	59.49±13.08[a]	43.58±5.30[a]	31.52±2.21[b]	51.78±8.41[a]
Met	71.50±4.73[a]	71.04±3.21[a]	57.80±17.67[b]	72.02±19.27[a]
Thr	72.17±20.32[a]	54.79±7.22[a]	41.56±8.21[b]	41.22±5.30[b]
Ile	55.67±16.72[a]	64.85±9.12[a]	32.27±2.98[a]	63.86±0.17[a]
Leu	84.82±0.47[a]	60.35±10.41[ab]	33.11±9.52[b]	49.55±5.18[b]
Phe	63.11±7.96[a]	55.02±7.01[a]	43.69±7.90[a]	62.90±0.88[a]
His	74.11±0.21[a]	60.13±5.29[a]	52.50±14.33[a]	67.73±11.93[a]
Arg	73.52±5.51[a]	40.81±7.02[ab]	29.81±7.04[b]	52.58±13.36[ab]
Val	44.79±4.16[a]	66.80±10.55[a]	50.05±8.33[a]	65.03±3.27[a]
Tyr	62.02±6.02[ab]	58.92±4.55[ab]	38.35±14.49[a]	77.22±9.43[b]
Asp	87.00±8.37[a]	61.09±16.03[ab]	55.24±7.95[ab]	34.96±3.68[b]
Ser	42.10±3.73[a]	59.14±10.55[a]	39.71±10.96[a]	57.43±7.20[a]
Glu	55.61±26.71[a]	67.99±14.77[a]	50.22±23.15[a]	46.95±0.50[a]
Gly	84.81±1.25[a]	75.86±11.77[a]	71.83±4.06[a]	82.29±2.52[a]
Ala	53.00±2.74[a]	65.50±14.55[a]	50.27±21.55[a]	59.12±0.58[a]
Pro	49.81±16.30[a]	50.24±5.16[a]	34.04±2.07[a]	44.05±23.82[a]
Average	64.60±9.57[a]	59.76±11.40[a]	44.50±11.29[b]	58.04±6.57[a]

[a, b] Means within a row with different subscripts letters differ significantly ($p<0.05$).

meal sample A and double low rapeseed meal sample B, C and D was 53.07, 43.34, 48.96 and 76.22%, and 41.52, 44.55, 48.44 and 81.02%, respectively for DM and CP. Individual values for amino acid degradability in the rumen for the four meal samples are given in Table 2 and average degradation values for all amino acids was 66.20, 61.12, 78.43 and 89.50% for sample A, B, C and D, respectively. The ratio of the average amino acid degradability value to the crude protein degradability value for each sample was 1.59, 1.37, 1.62 and 1.10, respectively. In double low rapeseed meal samples the degradability of dry matter and crude protein was significantly higher for sample D that processed by low temperature press than for sample B or C which processed by prepress-extraction and screw press. This could be due to the high temperature employed in the course of these processes.

For individual amino acids the degradability values of traditional rapeseed meal sample A was higher than that of

Table 4. The contents of nitrogen and amino acid in dietary fiber of rapeseed meal samples (%) (dry matter base)

	Traditional rapeseed meal	Double low rapeseed meal		
	Sample A	Sample B	Sample C	Sample D
Crude fiber	9.01	9.44	7.48	6.71
NDF	35.88	38.12	41.01	23.73
Crude protein	5.26	7.93	8.64	0.72
Total amino acid	6.67	12.14	9.37	1.72

double low rapeseed meal sample B. In double low rapeseed meals, sample D that processed by low temperature press had the highest degradability value of amino acid and significantly than that of sample B and C.

Digestibility of amino acids in residual protein as determined by the precision-fed rooster bioassay

The data in Table 3 show that the digestibility of the amino acids in residual protein as measured by the precision-fed rooster bioassay was similar for sample A and sample D. In double low rapeseed meal samples, sample B that processed by prepress-extraction had a higher digestibility of amino acids, similar to that of sample D, than sample C. The results suggest that the processing methods markedly affect the digestibility of amino acids in the residual protein, but variety of rapeseed had not effect. However, when compared with total amino acid availability involving the digestibility of amino acids in the rumen and rooster bioassay (total availability = degradability in rumen +(1-degradability/100)×digestibility of residual protein in rooster bioassay) there were not statistically significant differences for these four rapeseed meal samples. Double low rapeseed meal sample D had higher total availability of amino acids (95%) than that of sample B (84%), sample C (88%) and sample A (88%).

As indicated above, sample A and B had significant difference ($p<0.05$) in the degradability of dry matter and crude protein although these two samples both processed by prepress-extraction. However, the data in Table 2 and 3 show that the breed of rapeseed meal had not significant effect on the degradability of average amino acids in rumen and the digestibility of amino acids in residual protein. The results also suggest in double low rapeseed meal samples, the processing mothods affect the contents of amino acids in the residual protein, the degradability of dry matter, crude protein and amino acids of rapeseed meal in the rumen and the digestibility of amino acids in the residual protein. In terms of degradability and digestibility of amino acids in rapeseed meal, prepress-extraction is considered to be the best method to process the rapeseed according to the data of sample A and B. Li and Gao (1993) collected 179 rapeseed meal samples processed by different methods and evaluated the availability of amino acids and found that processing methods had strong effect. In this study the results of sample C (screw press, >120°C) and sample D (low temperature press, <80°C) were typical examples: Both the degradability of amino acid in rumen and subsequent availability of amino acids in the residual protein tended to be lower for sample C than for sample D and this result is in agreement with that reported by Chen and Campbell (2003). These results also suggested that although the methods of screw press protect the protein and amino acids in rumen, it decreased the digestibility of amino acids in residual protein. However, Aldrich et al. (1997) and Mashtaghi and Ingalls (1995) suggested that moisture heat treatment of soybean meal and canola meal could increase the availability of amino acids in the residual protein. Griffin et al. (1993) showed similar results in the assessment of amino acid digestibility of soybean meal. The difference between these results could be due to the difference of moisture heat treatment and dry heat treatment.

With regard to the excessive heat treatment the composition of dietary fiber in the rapeseed meal samples (Table 4) is an important indication and which is not concerned and noted in the previous research. The high content of protein and amino acids in the dietary fiber component of double low rapeseed meal sample B and C in comparison to sample D that processed by low temperature press could be due to an excessive Maillard reaction-product formation, which always happens in the process, and this reaction-product contains unavailable amino acids.

These results indicate that the processing methods of rapeseed meal have significant effect on degradability of amino acids in rumen and subsequent availability of amino acids in the residual protein, but the breed of rapeseed meal had not significant effect on these indexes. The results also inferred that excessive heat treatment decreased the availability of amino acids of rapeseed meal. In the actual production, rapeseed meal contained high contents of fiber are not suitable for raising bypass protein by dry heat treatment especially in the process of rapeseed meal.

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