# Assessment of Ruminal and Post Ruminal Amino Acid Digestibility of Chinese and Canadian Rapeseed (Canola) Meals*

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**ABSTRACT :** Two rapeseed meal samples (Sample A, hybrid 5900 and sample B, double low rapeseed No.4) obtained from China and one Canola meal sample obtained from a local crushing plant in Canada were used to investigate the amino acid degradability of rapeseed/Canola meal in rumen and amino acid digestibility of ruminal incubation residues by precision-fed rooster bioassay. Results show that in ruminal incubation the degradation rate of non amino acid nitrogen in crude protein is higher than that for amino acid nitrogen in crude protein, the results also suggest that the degradation rate of amino acid nitrogen in Chinese rapeseed meal sample B was lower than that for Canadian Canola, but that in Chinese rapeseed meal sample A is much close to that for Canadian canola meal. For all amino acids the digestibility of the bypass or residual protein as measured by the precision-fed rooster bioassay tended to be lower for Chinese rapeseed meal sample A than for sample B or Canadian canola meal which had similar digestibility values. However following a calculation of total amino acid availability, involving the digestibility of amino acids in the rumen and rooster bioassay the results are less contradictory. Results indicated that in traditional roasting-expelling process, heat treatment, especially dry heat treatmeat could decrease amino acids degradability in rumen of rapeseed/canola meal, but also may decrease total availability of amino acids of rapeseed/canola meal. ***(Asian-Aust. J. Anim. Sci. 2003. Vol 16. No. 7 : 979-982)***

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

## INTRODUCTION

Heat treatment has been used as a procedure to increase the bypass protein of feedstuffs for ruminants. Aldrich et al. (1997) and Moshtaghi and Ingalls (1995) showed that the heat treatment of soybean meal and canola meal could not only decrease the degradability of the feed protein in the rumen but also could increase the availability of amino acids in the bypass protein. Reports have also demonstrated that the heat-damaged whole soybeans resulted in a decrease in the intestinal digestibility of essential and nonessential amino acids (Stern et al., 1985; Faldet and Satter. 1991). In this regard the degree of heat treatment may affect overall digestibility of feed amino acids.

In the traditional production of rapeseed meal in China a roasting-expelling process is used and consequently excessive heat damage to the rapeseed protein may occur. The objective of the current study was to evaluate the digestibility of amino acids in the rumen and post ruminally for two types of Chinese rapeseed meal and to compare the results with that for Canadian canola meal.

## MATERIALS AND METHODS

### Rapeseed/canola meal samples

Two rapeseed meal samples (Sample A. hybrid 5900 and Sample B. double low rapeseed No. 4) obtained from China and one canola meal sample obtained from a local crushing plant in Canada were used in the study. The Chinese meals were prepared using the traditional roasting-expelling process whereas the Canadian canola meal was prepared using a pre-press solvent extraction process.

### Rumen incubation of samples

Two rumen-cannulated holstein cows fed a grass-corn silage diet were used for incubation of the meal samples. Nylon mesh bags (10 cm×2 cm. 50 μm porosity) containing 5 g rapeseed/canola meal sample were incubated in the rumen for 16 h. A total of 140 bags were prepared for each rapeseed/canola sample. A maximum of 30 bags divided equally among the three rapeseed/canola samples were incubated each day in each cow and the process was continued on 5 consecutive days until all 140 bags for each sample were incubated. After incubation, all bags were washed for 10 minutes in a cage adapted for placement in a wringer-type washing machine filled with cold tap water. The wash water was drained and the bags were washed for an additional 5 minutes in clean cold tap water. After washing all bags were dried in a forced-air oven at 60°C for 48 h and retained for analyses as the residual meal sample. A composite residual sample was obtained for each rapeseed/canola meal sample by combining 5 bags taken each day from each cow. The remainder of the bags for each rapeseed/canola meal sample were pooled for use in the precision-fed rooster bioassay.

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**Table 1.** Amino acid content of rapeseed/canola sample before and after 16 h rumen incubation

| Amino acid | Chinese rapeseed meal | | | | Canadian canola meal | |
|---|---|---|---|---|---|---|
| | Sample A | | Sample B | | | |
| | Original | Residual | Original | Residual | Original | Residual |
| ASP | 6.7 | 7.78 | 6.5 | 7.39 | 7.56 | 8.80 |
| THR | 3.98 | 4.71 | 3.88 | 4.35 | 4.24 | 5.26 |
| SER | 4.14 | 4.79 | 4.14 | 4.49 | 4.42 | 5.48 |
| GLU | 18.17 | 16.25 | 17.86 | 18.38 | 11.25 | 13.94 |
| PRO | 6.09 | 6.41 | 6.03 | 6.13 | 5.07 | 6.28 |
| GLY | 4.63 | 4.86 | 4.63 | 4.90 | 4.16 | 5.16 |
| ALA | 4.13 | 4.44 | 3.93 | 4.46 | 4.15 | 5.14 |
| CYS | 1.92 | 1.83 | 2.14 | 1.86 | 1.48 | 1.84 |
| VAL | 3.77 | 4.20 | 3.34 | 4.10 | 3.84 | 4.76 |
| MET | 1.59 | 1.53 | 1.62 | 1.69 | 1.38 | 1.72 |
| ILE | 2.79 | 3.13 | 2.45 | 2.96 | 2.98 | 3.69 |
| LEU | 6.23 | 6.63 | 5.86 | 6.69 | 6.0 | 7.44 |
| TYR | 2.36 | 2.96 | 2.19 | 2.73 | 2.91 | 3.61 |
| PHE | 3.53 | 3.92 | 3.37 | 3.84 | 3.63 | 4.50 |
| HIS | 2.25 | 2.11 | 2.19 | 2.22 | 1.73 | 2.15 |
| LYS | 3.27 | 3.44 | 3.05 | 3.24 | 4.3 | 5.33 |
| ARG | 4.79 | 4.60 | 4.37 | 4.75 | 4.22 | 5.23 |

**Precision-fed rooster bioassay**

The precision-feeding TME technique of Sibbald as modified by Campbell (Zhang et al., 1994) was used to determine amino acid digestibility. The residual samples were combined with a non-nitrogen diet (90% glucose-10% oil) at a ratio of 2:1 and 25 g was precision-fed to each of 10 birds per rapeseed/canola meal sample. Endogenous amino acid losses were determined for birds precision-fed 25 g of the non-nitrogen diet. All assays were conducted using cecectomized roosters.

**Chemical analyses**

The original and residual rapeseed/canola meal samples were analyzed in duplicate for dry matter, crude protein (Kjeldahl N×6.25) and amino acids. Amino acids were determined by ion-exchange chromatography following hydrolysis of the sample in 6 N HCl at 110°C for 24 h.

**Statistical analysis of data**

Statistical analysis of data was couducted with SAS.

## RESULTS AND DISCUSSION

**Amino acid content**

The data in Table 1 show the amino acid contents of original samples of rapeseed/canola meal and the amino acid contents of residual following rumen incubation for 16 h. For both Chinese rapeseed meals and to a lesser extent for the Canadian canola meal the amino acids were enriched in the residual samples. When compared relative to the crude protein contents of the samples the enrichment in amino acid contents was greater for the Chinese rapeseed meal samples than for Canadian canola meal. The recovery of amino acid nitrogen was 80.8, 84.6, 77.7, 84.2, 89.1, 90.3% for the original and residual samples of Chinese sample A, sample B and Canadian canola, respectively. Overall these data indicate that in ruminal incubation the degradation rate of non amino acid nitrogen in crude protein is higher than that for amino acid nitrogen in crude protein. However, the results suggest that the degradation rate of amino acid nitrogen in Chinese rapeseed meal is lower than that for Canadian canola.

**Table 2.** Rumen degradability of individual amino acids for Chinese rapeseed meal and Canadian canola meal following 16 h incubation (%)

| Amino acid | Chinese rapeseed meal | | Canadian canola meal |
|---|---|---|---|
| | Sample A | Sample B | |
| ASP | 70.9±0.21$^{a}$ | 35.7±0.98$^{b}$ | 71.2±3.29$^{a}$ |
| SER | 71.0±0.21$^{a}$ | 38.5±0.94$^{b}$ | 69.9±3.44$^{a}$ |
| GLU | 77.6±0.16$^{b}$ | 80.6±0.30$^{a}$ | 82.6±1.98$^{a}$ |
| PRO | 73.6±0.19$^{b}$ | 42.5±0.88$^{c}$ | 72.3±2.59$^{a}$ |
| GLY | 73.7±0.19$^{a}$ | 40.3±0.92$^{b}$ | 74.1±2.95$^{a}$ |
| ALA | 73.0±0.18$^{a}$ | 35.8±0.99$^{b}$ | 70.8±3.31$^{a}$ |
| CYS | 76.1±0.17$^{b}$ | 50.7±0.76$^{c}$ | 80.4±2.23$^{a}$ |
| THR | 70.4±0.21$^{a}$ | 36.6±0.97$^{b}$ | 68.4±3.61$^{a}$ |
| VAL | 72.1±0.20$^{a}$ | 30.7±1.06$^{c}$ | 67.1±3.75$^{b}$ |
| MET | 76.0±0.18$^{a}$ | 41.1±0.91$^{b}$ | 73.6±3.00$^{a}$ |
| ILE | 71.9±0.20$^{a}$ | 31.8±1.05$^{c}$ | 66.9±3.71$^{b}$ |
| LEU | 73.3±0.19$^{a}$ | 35.5±0.97$^{b}$ | 71.9±3.20$^{a}$ |
| TYR | 68.5±0.21$^{a}$ | 29.6±1.08$^{b}$ | 66.6±3.77$^{a}$ |
| PHE | 72.1±0.21$^{a}$ | 35.7±0.97$^{b}$ | 69.0±3.53$^{a}$ |
| HIS | 75.5±0.17$^{b}$ | 42.6±0.89$^{c}$ | 79.5±2.34$^{a}$ |
| LYS | 73.6±0.19$^{a}$ | 39.6±0.93$^{c}$ | 75.2±2.83$^{a}$ |
| ARG | 75.9±0.18$^{a}$ | 38.5±0.94$^{b}$ | 77.4±2.72$^{a}$ |
| Average | 73.3 | 40.3 | 73.1 |

$^{a, b, c}$ Means within a row with different subscripts differ significantly ($p<0.05$).

**Rumen degradability of dry matter, crude protein and amino acids**

The degradability in the rumen of Chinese rapeseed meal samples A, B and Canadian canola was 42.0, 25.4 and 38.7%, respectively for dry matter and 72.6, 43.4 and 75.1%, respectively for crude protein. Individual values for amino acid degradability in the rumen for the three meal samples are given in Table 2 with average degradability values for all amino acids of 73.3, 40.3 and 73.1% for Chinese rapeseed sample A, B and Canadian canola meal, respectively. The ratio of the average amino acid degradability value to the crude protein degradability value for each sample was 1.01, 0.93 and 0.97 for Chinese rapeseed sample A, B and Canadian canola meal, respectively. Corresponding values for amino acid percent degraded in the crude protein were 79.9, 72.2 and 86.7%, respectively. The data indicate that the overall degradability of dry matter and protein was similar for the Chinese rapeseed meal sample A and Canadian canola meal but

**Table 3.** Amino acid digestibility for rumen residual samples of Chinese rapeseed meal and Canadian canola as determined by the precision-fed rooster bioassay (%)

| Amino acid | Chinese rapeseed meal | | Canadian canola meal |
|---|---|---|---|
| | Sample A | Sample B | |
| ASP | 53.6±10.8[b] | 67.7[a]±2.76[b] | 88.8±10.14[a] |
| SER | 56.5±11.07[a] | 68.0±4.05[a] | 79.8±10.29[a] |
| GLU | 71.3±9.13[a] | 81.1±1.90[a] | 86.3±5.07[a] |
| PRO | 49.8±9.18[b] | 64.5±5.65[a] | 77.6±6.56[a] |
| GLY | 57.4±8.23[a] | 66.6±4.19[a] | 69.2±8.55[a] |
| ALA | 62.2±10.48[a] | 73.3±2.81[a] | 82.6±6.37[a] |
| CYS | 31.6±6.97[a] | 48.5±6.51[a] | 49.2±9.61[a] |
| THR | 53.1±9.78[a] | 65.2±3.38[a] | 62.4±8.40[a] |
| VAL | 57.1±7.83[b] | 69.1[a]±3.96[b] | 71.4±6.21[a] |
| MET | 81.0±9.48[b] | 88.8[a]±2.41[b] | 92.0±3.25[a] |
| ILE | 61.8±11.5[b] | 72.0[a]±4.80[b] | 76.8±5.79[a] |
| LEU | 64.5±9.93[a] | 75.9±3.21[a] | 77.4±4.28[a] |
| TYR | 59.6±10.16[b] | 72.6[a]±3.93[b] | 79.6±5.05[a] |
| PHE | 62.8±11.60[b] | 76.6[a]±3.28[b] | 77.6±4.71[a] |
| HIS | 54.1±10.35[a] | 66.8±5.20[a] | 75.0±10.28[a] |
| LYS | 49.7±9.61[b] | 59.2±5.85[a] | 76.5±8.69[a] |
| ARG | 68.6±10.29[a] | 79.7±4.16[a] | 84.8±4.60[a] |
| Average | 58.5 | 79.5 | 79.3 |

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

markedly lower for Chinese rapeseed meal sample B. This could be due to heat-damage to protein wile rapeseed meal sample B was prepared using the traditional roasting-expelling process.

For individual amino acids the variability among amino acids was similar for Chinese rapeseed meal A and Canadian canola meal. Chinese rapeseed meal B showed a higher variability among individual amino acids.

**Digestibility of amino acids in bypass protein as measured by the precision-fed rooster bioassay**

Although not statistically significant for all amino acids the digestibility of the bypass or residual protein as measured by the precision-fed rooster bioassay tended to be lower for Chinese rapeseed meal sample A than for sample B or Canadian canola meal which had similar digestibility values. With regard to rumen degradability of the protein in the original sample of the two Chinese rapeseed meals, sample A had a higher degradability, similar to that for Canadian canola meal, than sample B. However following a calculation of total amino acid availability, involving the digestibility of amino acids in the rumen and rooster bioassay the results are less contradictory (Table 4). The data in Table 4 indicate that the total availability or disappearance of amino acids, on average, is similar for Chinese rapeseed meal sample A and Canadian canola meal (95.2 vs 94.9) and higher than that for Chinese rapeseed meal sample B (87.7).

**Table 4.** Total availability[1] of amino acids from original and residual samnples of Chinese rapeseed meal and Canadian canola meal

| Amino acid | Chinese rapeseed meal | | Canadian canola meal |
|---|---|---|---|
| | Sample A | Sample B | |
| ASP | 93.6±0.04[a] | 85.3±0.23[b] | 93.4±0.75[a] |
| SER | 94.5±0.05[a] | 87.6±0.19[b] | 93.8±0.71[a] |
| GLU | 97.4±0.02[b] | 97.6±0.04[b] | 98.0±0.23[a] |
| PRO | 94.3±0.04[b] | 87.5±0.21[c] | 95.3±0.54[a] |
| GLY | 94.5±0.11[a] | 86.5±0.21[b] | 94.3±0.65[a] |
| ALA | 95.4±0.04[a] | 88.0±0.19[c] | 94.2±0.66[b] |
| CYS | 93.0±0.05[b] | 85.8±0.22[c] | 95.2±0.55[a] |
| THR | 93.1±0.05[a] | 84.0±0.25[c] | 91.9±0.92[b] |
| VAL | 93.9±0.05[a] | 82.1±0.28[c] | 91.6±0.96[b] |
| MET | 98.8±0.01[b] | 94.6±0.08[c] | 99.0±0.12[a] |
| ILE | 95.1±0.03[a] | 86.4±0.21[c] | 93.9±0.69[b] |
| LEU | 96.2±0.03[a] | 89.2±0.17[c] | 95.5±0.51[b] |
| TYR | 95.6±0.60[a] | 87.3±0.20[c] | 94.4±0.63[b] |
| PHE | 96.3±0.03[a] | 90.1±0.15[c] | 94.8±0.59[b] |
| HIS | 95.6±0.03[a] | 85.3±0.23[b] | 95.4±0.52[a] |
| LYS | 93.5±0.05[b] | 79.9±0.31[c] | 95.1±0.56[a] |
| ARG | 98.0±0.02[a] | 92.9±0.11[b] | 97.8±0.26[a] |
| Average | 95.2 | 87.7 | 94.9 |

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

[1] Total availability=Degradability in rumen+(1-Degradability×100)·Digestibility of residual in rooster bioassay.

**Table 5.** Composition of dietary fiber in Chinese rapeseed meal and Canadian canola meal (% of dry matter)

| Amino acid | Chinese rapeseed meal | | Canadian canola meal |
|---|---|---|---|
| | Sample A | Sample B | |
| Non-starch Polysaccharides | 21.1 | 19.6 | 20.2 |
| Legnin and polyphenols | 10.5 | 10.1 | 9.3 |
| Protein (Kjeldahl nitrogen×6.25) | 20.7 | 18.7 | 3.7 |
| Minerals (Ash content in NDF) | 3.6 | 1.7 | 1.1 |
| Total | 56.0 | 50.2 | 34.5 |

**Digestibility of crude protein for original and residual samples of Chinese rapeseed meal and Canadian canola meal determined *in vitro***

The *in vitro* protein digestibility values for Chinese rapeseed meal samples A and B were, respectively, 62.6 and 61.2% and comparatively lower than that for Canadian canola meal (71.6%). The digestibility of the residual protein samples as measured by the *in vitro* technique were 40.3, 52.5 and 52.8%, respectively for Chinese rapeseed meal sample A, B and Canadian canola meal. These latter data showed the same pattern as for amino acid digestibility values were also similar among samples (Chinese rapeseed meal sample A, 83.7; sample B, 73.1 and Canadian canola meal 88.3.

As indicated above the Chinese rapeseed meal samples

were exposed to a higher degree of heat treatment during process than that for the Canadian canola meal. The effects of the excessive heat treatment can be noted in the composition of dietary fiber in the samples (Table 5). The high content of protein (nitrogen) in the dietary fiber component of the Chinese rapeseed meals in comparison to the Canadian canola meal is an indication of extensive mallard reaction-product formation during excessive and prolonged heat treatment. Although the composition of the dietary fiber was similar for the two Chinese rapeseed meal samples the apparent effects on rumen degradability of protein and subsequent availability of amino acids in the residual protein following rumen incubation were different. While sample A did not show much difference regarding reduction of rumen degradability of amino acids the availability of the amino acids in the residual protein was low. The converse was true for sample B which showed low degradability of protein in the rumen but relatively high availability of amino acids in the residual protein. Overall the total availability of amino acids was shown to be superior for sample A and more similar to that for Canadian canola meal. In this regard the data for the two Chinese rapeseed meal samples are only in partial agreement with that reported by Aidrich et al. (1997) and Mashtaghi and Ingalls (1995) who indicated that heat treatment of soybean and canola could not only decrease the degradability of feed protein in the rumen but also increase the availability of amino acids in bypass protein. Some of the discrepancy in the data could be due to a different type of heat treatment as in the latter cited experiments moist heat treatment was used while in the traditional Chinese processing of rapeseed a dry heat treatment is often used. Further research is needed to explain the effects of heat treatment on amino acid availability.

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