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Fundamental Study on Nutritional Evaluation for Rapeseed Meal

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Abstract

This fundamental study was undertaken to evaluate the nutritional value of Canola rapeseed meal which has been increasingly used as a by-product with the demand for the food oil resource. To compare the nutritive values among rapeseed meal and soybean meal, two experiments were carried out by using rats. One was a digestibility test of rapeseed meal and the other was the growth rate of rats for 21 days. The chemical compositions, glucosinolate and amino acids of defatted rapeseed meal and defatted soybean meal were analyzed. After one week feeding, nitrogen excretion in rats was measured to study FER, PER, TD, BW, and NPU of the meals. The amount of crude proteins in defatted rapeseed meal and defatted soybean meal were 45.5% and 37. 9%. The glucosinolate content of defatted rapeseed meal was 0.04%. The body weight gain of defatted rapeseed meal was not significantly different from that of defatted soybean meal ($p>0.01$). After one week feeding, there was no significant differences in organ weights and serum components between two groups ($p>0.01$). It was presumed that the rapeseed meal has enough possibility for developing food to use as a protein source like a soybean meal protein. However, more careful experiments are needed to clarify the nutritional value of rapeseed meal of Canola since the lipids composition of blood tended to be different when the rapeseed meal and soybean meal were used.

Key words : rapeseed protein, growth of rat, digestibility

INTRODUCTION

Rapeseed is a major oilseed in Canada and provides protein and oil. The production of rapeseed is the fifth among the oilseeds[1]. The Canola is a major rapeseed family which has been known to have a little amount of malnutritive components such as erucic acid or glucosinolates[2]. As a lipid source, the consumption of Canola has been incresasing. The utilization of defatted rapeseed meal produced during lipid manufacture has been also increasing. The nutritional quality of rapeseed meal is better than that of legume or wheat meals[3]. The rapeseed meal is nutritious due to the composition of amino acids[4-6] and is rich in lysine and sulfur-containing amino acids[7]. However, defatted rapeseed meal is mainly utilized as a source of feeds and fertilizers.

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The study of the application of the protein, which corresponds to 40 to 45% in rapeseed meal[2,4,5,8,9], to the food industry is very limited. Therefore, the effects of defatted rapeseed meal on the growth of rats were investigated to study the utilities and nutritional qualities of defatted rapeseed meal. Food efficiency ratio (FER), protein efficiency ratio (PER), true digestibility (TD), biological value (BV), and net protein utilization (NPU) were determined by measuring nitrogen excretion and the results were compared with those of defatted soybean meal.

MATERIALS AND METHODS

Materials

Defatted rapeseed meals (*Canola* sp.) and defatted soybean meals were supplied by Toyo Seiyu Co. Ltd. (Japan) and Ajinomoto Co. Ltd. (Japan), respectively. Four weeks old Wistar male rats were purchased from

Tokyo Laboratory Animals Science Co. Ltd. (Japan).

Methods

The chemical compositions[10], glucosinolate[11] and amino acids[12] of defatted rapeseed meal and defatted soybean meal were analyzed.

Samples for amino acids were hydrolysed for 24h in 2ml of 6N HCl at 100° C in vacuum hydrolysis tubes and amino acids were determined by high performance ion exchange chromatography using a Shimazu Amino Acid Analyser, System LC-6A. Total glucosinolate was calculated from the determination values of OZT (L-5-Vinyl-2-Oxazolidinethione) and ITC (Isothiocyanates).

Samples were sifted with 30mesh sieves. After one week of preliminary feeding, Wistar male rats weighing sixtg grams were divided into two groups, one was defatted rapeseed meal group and the other was defatted soybean meal group. Each group had fourteen rats. To measure the nitrogen excretion, seven rats were selected as a non-protein group. Each meal was formulated to contain twenty percent of protein according to the meal compositions of AIN-76. Proteins such as casein or egg protein are generally used to evaluate protein quality. However, defatted soybean meals as well as defatted rapeseed meals were used as a control group, since the objective of this experiment was to calculate wheather the rapeseed protein could be practically used as a protein source compared to soy protein which was a reference. For the future study, the casein based on ANRC will be used as a reference protein to compare the rapeseed protein with total protein including animal and vegetable protein.

The meals were *ad libitum* fed to each group for one week and body weight gain and food intake were measured daily. Rats were individually housed in metabolic cages under the room conditions of constant temperature (22±3° C), and a 12h cycle of light (7a.m.~7p.m.) and dark (7p.m.~7a.m.). After one week feeding, the urine and feces were collected for 24h and nitrogen excretion was measured to study FER, PER, TD, BV and NPU of the meals. The total nitrogen content of the samples was determined by the Kjeldahl method. TD was caculated as follows :

$$TD\% = \frac{\text{Total intake of N} - (\text{N in Feces} - \text{endogeneous N in Feces})}{\text{Total intake of N}} \times 100$$

The organ weights and serum components of the rats were also investigated after slaughtering seven rats from each group. Feeding and growth of seven rats from each group were determined after two weeks. The changes in organ weights and serum components of the rats were also studied by slaughtering rats after three weeks of feeding.

RESULTS AND DISCUSSION

The results of proximate and glucosinolate analysis and amino acid compositions in defatted rapeseed meal and defatted soybean meal were shown in Table 1 and 2, respectively.

The amounts of crude proteins in defatted rapeseed meal and defatted soybean meal were 45.5% and 37.9%, respectively. The results were almost same as those of previous reports[2,4,5,6,8]. The content of crude fiber in defatted rapeseed meal was 10.5% which is twice as much as 5.0% in defatted soybean meal. The glucosinolate content of defatted rapeseed meal was 0.04% which was relatively low. The results of amino acid compositions in defatted rapeseed meal were slightly different from Clandinin *et al.* results[13]. However, the differences in samples and oil extraction processes shoud be carefully considered since the results of this paper were also different from Girault's[14] and Lee *et al.* results[15].

Fig. 1 showed the growth curve of the rats and Table 3 indicated the body weight gain, food intake, FER and PER. The body weight gain of defatted rapeseed meal was not significantly different from that of defatted soybean meal ($p>0.01$).

Table 1. Proximate and glucosinolate analysis of rapeseed meal and soybean meal

	Rapeseed meal(%)	Soybean meal(%)
Moisture	12.8	12.1
Crude protein	37.9	45.5
Crude lipid	1.5	0.9
Crude fiber	10.5	5.0
Ash	6.6	6.1
Glucosinolate	0.04	-

TD, BV and NPU of defatted rapeseed meal and defatted soybean meal were shown in Table 4. TD and BV of defatted rapeseed meal were significantly different ($p<0.01$) from those of defatted soybean meal, however no significant differences in NPU were found between two groups ($p>0.01$). After one week of feeding, there was no significant differences in organ weights (Table 5) and serum components (Table 6) between the two groups ($p>0.01$). There was also no significant differences in organ weights except liver weight between two groups after three week feeding ($p>0.01$). The liver weight of defatted rapeseed meal group was greater than that of defatted soybean meal group due to body weight differences.

Further studies are needed on lipid components because serum lipid contents of defatted rapeseed meal group were lower than those of defatted soybean meal group. It is postulated that the nutritional quality of protein in defatted rapeseed meal is almost as same as that in defatted soybean meal. However, the TD of defatted rapeseed meal is lower than that of defatted soybean meal due to the tannin components of outshell[16] in defatted rapeseed meal. Therefore, dehulling of defatted rapeseed meal is required to get the precise information on protein utilization ratio *in vivo* system.

Table 2. Amino acid composition

(g/100g sample)

Amino acid	Rapeseed meal	Soybean meal*
Hyp	N.D.	N.D.
Thr	N.D.	1.8
Ser	3.8	N.D.
Glu	10.2	N.D.
Pro	3.8	N.D.
Gly	8.6	2.0
Ala	6.1	N.D.
Val	2.8	2.1
Cys	3.8	1.4
Met	1.5	0.5
Ile	1.8	2.1
Leu	5.8	3.4
Tyr	1.3	1.5
Phe	2.5	2.3
His	1.9	1.2
Lys	4.9	2.9
Arg	3.5	3.4
Try	N.D.	0.6
Others	37.7	74.8

*Toyo Seiyu Co. Ltd.

CONCLUSIONS

The growth, organ weight, serum components, and

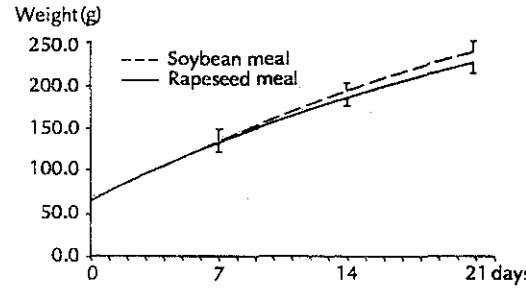

Fig. 1. Growth curve of rats fed the experimental diets for 3 weeks (Mean±SD, n=7).
Effect of treatments is not significant.

Table 3. Body weight gain, food intake, food efficiency, and protein efficiency at 7 and 21 days

Group/Exp. term	Body weight gain(g)	Food intake (g)	Food efficiency ratio (FER)	Protein efficiency ratio (PER)
Rapeseed meal / 7days	69.7± 7.0	128.3± 8.4	0.53±0.04	2.78±0.20
/21days	160.7±13.9	473.3±21.9	0.35±0.01	1.80±0.05
Soybean meal / 7days	73.2± 9.6	120.7±12.2	0.60±0.04	2.94±0.36
/21days	167.5±19.7	451.3±26.5	0.38±0.03	1.93±0.20

Mean±SD for 7 rats

Table 4. True digestibility, biological value and net protein utilization at 7 days

Group	True digestibility (TD) %	Biological value (BV) %	Net protein utilization (NPU)
Rapeseed meal	68.6±2.6[a)]	70.2±5.5[a)]	49.2±4.4
Soybean meal	80.9±3.2	57.2±9.8	46.4±8.7

Means±SD for 7 rats. [a)]Significantly different from soybean meal group ($p<0.01$)

Table 5. Organ weight of rats at 7 and 21 days

Organs	Rapeseed meal (g/100g B. W.)		Soybean meal (g/100g B. W.)	
	at 7days	at 21days	at 7days	at 21days
Liver	5.15±0.43	4.29±0.28[a]	4.08±0.28	3.77±0.17
Spleen	0.37±0.09	0.29±0.06	0.37±0.06	0.29±0.06
Kidney	0.97±0.03	0.91±0.04	0.99±0.09	0.89±0.06
Heart	0.33±0.05	0.34±0.03	0.38±0.02	0.35±0.03
Pancreas	0.35±0.08	0.32±0.07	0.32±0.16	0.32±0.08
Spermary	1.05±0.11	1.00±0.04	1.06±0.11	1.05±0.08
Lungs	0.56±0.04	0.49±0.06	0.58±0.09	0.51±0.07
Stomach	0.76±0.08	0.64±0.06	0.84±0.13	0.64±0.05
Small intestine	2.91±0.75	2.24±0.54	2.87±0.44	2.26±0.32
Large intestine	0.68±0.09	0.55±0.10	0.79±0.14	0.54±0.07
Appendix	0.67±0.11	0.50±0.13	0.59±0.11	0.55±0.12

Values are mean±SD of 7 rats
[a] Significantly different from soybean meal group ($p<0.001$)

Table 6. Serum components of rats fed experimental diets for 7 and 21 days

Serum components	Rapeseed meal (g/100g B. W.)		Soybean meal (g/100g B. W.)	
	at 7days	at 21days	at 7days	at 21days
T. P. (g/dl)	4.99± 0.12	5.09± 0.30	5.29± 0.48	5.05± 0.91
A/G	0.80± 0.04[a]	0.68± 0.07	0.75± 0.04	0.70± 0.05
B.N.U. (mg/dl)	14.29± 3.25	11.25± 2.55[b]	20.43±10.13	20.88± 6.24
Creatinine (mg/dl)	0.21± 0.07	0.35± 0.08	0.24± 0.05	0.39± 0.10
Urea acid (mg/dl)	1.73± 0.25	2.03± 0.24	2.08± 0.62	1.91± 0.47
T-Cho (mg/dl)	83.43± 7.72	78.50±12.86	92.71±12.91	84.63± 23.13
T. G. (mg/dl)	83.00±21.86	76.00±34.08	80.86±25.57	88.29± 23.40
T. L. (mg/dl)	377.29±36.98	344.25±67.11	397.43±50.45	406.50±113.02
N.E.F.A. (mEg/dl)	0.56± 0.17	0.76± 0.12[b]	0.61± 0.22	1.25± 0.32

Values are mean±SD of 7 rats
[a] *Significantly different from soybean meal group* ($p<0.05$)
[b] Significantly different from soybean meal group ($p<0.01$)

NPU of defatted rapeseed meal were not significantly different from those of defatted soybean meal ($p>0.01$). Conclusively the protein in defatted rapeseed meal as well as in defatted soybean may be used for food manufacturing and processing.

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탈지유채종자의 영양평가에 관한 기초적 연구

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요 약

식물유자원으로서 사용이 증가되고 있는 유채에 대한 영양학적인 기초연구를 목적으로 유채의 일반성분, glucosinolate, amino acid 분석을 시도하였다. 또한 유채종자의 주 성분인 단백질의 품질을 측정하기 위하여 20% 수준의 단백질을 사료로 Wistar계 수컷쥐를 사육하여 사료효율(FER), 단백질효율(PER), 정미단백질효율(NPU), 소화율(TD) 및 생물가(BU)를 측정하였으며 장기증량과 혈액성분도 아울러 조사했다. 조단백질량은 탈지대두 45.5%, 탈지유채종자 37.9%였고, 조섬유량은 탈지대두 5.0%에 비교해서 탈지유채종자에서는 10.5%로 약 2배였다. 또한 glucosinolate량은 0.04%였다. 탈지유채종자군은 탈지대두군과 비교해서 체중 증가에 유의차는 인정되지 않았으며, 동등한 성장을 나타냈다. 장기증량, 혈중성분에도 특별히 유의한 차이는 없었다. 또한 정미단백질효율도 유의차가 없었다. Rat에 의한 *in vivo* 실험에서 탈지유채종자에 많이 함유된 단백질은 탈지대두단백질과 거의 동등한 영양적 가치를 갖는 것으로 생각되며, 앞으로 식품에의 응용 이용이 가능하다고 할 수 있다.