

Effect of Rice Bran and *Leucaena* Supplementation on the Growth Performance of Goats Fed with Urea Treated Rice Straw

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Abstract

An experiment was conducted for 90 days to determine the effect of energy level using different levels of RB on the UTRS as a basal diet supplemented with fixed level of *Leucaena* on growing goats. Experimental diets included four levels of rice bran: 0% rice bran (RB), 10% RB, 20% RB, and 30% RB in basal diets. A total of 20 growing female goats of 5 to 6 months age were randomly allocated into four different dietary groups. Findings showed that inclusion of 20 % rice bran significantly ($P < 0.05$) improved in total DMI than the other levels. A 30 % RB inclusion was not able to improve further the total DMI, which might be due to the negative effect of higher level of anti-nutritional factor in rice bran. *In-situ* degradation of D_3 and D_4 recorded the higher estimated solid outflow rate indicating on the improvement on digestion of feedstuffs. The 20 and 30% RB inclusion resulted to significantly ($p < 0.05$) higher OM digestibility of UTRS-based diet with *Leucaena* supplementation. ADG (41.1g), FCE (10.96) and benefit over feed cost Philippine Peso 238.2) was significantly higher in diet groups with 20 % RB inclusion. Based on the results, it can be concluded that the supplementation of rice bran at 20 % level is economic net income (US\$ 2.040 /goat) in feeding goats with UTRS based diet and supplemented with 20 % of *Leucaena*.

Key words: goat, urea treated rice straw, rice bran, digestibility, growth performance

Introduction

Rice is the major staple food of the people in Asian countries. About 576 mt of rice straw is produced in Asia (FAO 2000). Nepal annually produces about 4.5 mt of it. Between the crop residue and agro-industrial by-products, rice straw contributes about 40 %. Therefore, the availability of rice straw in the country indicates potentially higher level of feed resource for ruminants. But the use of rice straw as a feed to ruminants is limited due to the low content of N, readily available energy and minerals, which are not adequate to maintain the requirements of the animals. The other problems associated with rice straw are its low digestibility, low intake by ruminant animals higher level of silica and high degree of lignifications (Sahoo 2000). The undegradable lingo-cellulosic complex reduces the availability of fermentable substrate in the ration of the farm animals (Ørskov 2000). Due to these limitations, there is a need to improve the nutritive value of rice straw.

However, even if the nutritive value of the rice straw is improved by urea treatment, it alone cannot supply nutrients beyond the maintenance level (Sharma *et al.*

1995). To correct the nutritional imbalance of rice straw based diet, supplementation of energy and protein rich concentrate has often been suggested (Umunna *et al.* 1995). Nevertheless, to avail of the added N in the form of urea in the straw, supplementation to provide readily available energy to rumen microbes is needed. Rice bran is locally available and a cheap energy source. It supplies energy to the rumen and ensures synchronicity of protein and energy in UTRS based diet for more efficient utilization and microbial protein synthesis. But the higher level affects microbial growth and ultimately affects the nutrient digestibility. Therefore, it is important to find out the suitable level of RB for maximum growth among ruminants.

Leucaena leucocephala is rich in by-pass protein and minerals. It is widely grown in Asian region. It can also be used as a supplement to straw based diet to improve microbial growth and fiber digestion in the rumen of ruminants (Murry *et al.* 1990).

Therefore, this study was aimed to determine the effects of different levels of rice bran (RB) as an energy supplement on the utilization of urea treated rice straw (UTRS) supplemented with fixed level of *Leucaena* on the digestibility and growth performance of upgraded goats. The study was conducted at the Small Ruminant Center, Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines from October 2003 to February 2004.

Materials and Methods

Rice straw treatment

About 50g of fertilizer grade urea (46% N) was dissolved in 9 l of water and evenly sprayed on 10 kg of rice straw providing 23g N per kg DM as suggested by Chenost *et al.* 1997. The treated rice straw was thoroughly mixed and packed in polyethylene sack. Air was removed from the sack using a vacuum pump to insure anaerobic condition. The sacks were tightly secured with rope and incubated at room temperature of about 20 to 30°C. After 15 days of curing, the sacks were opened and the straw was spread on the concrete floor to allow drying for 48h and ensure evaporation of excess ammonia.

Experimental design diets and animal feeding

A 90-day trial was conducted using 20 growing goats (50 % Cross of Boar and Philippine native goats) with age ranging from 4-5 months and of similar live weight was randomly distributed into four different treatment groups following a completely randomized design (CRD). A 14-day adjustment period was adopted prior to start of the trial. Longer adjustment period was adopted to ensure the normal consumption of the basal diet (Rymer 2000). Animals were kept in individual pens equipped with feeder and water trough. Animals were drenched against internal parasites seven days before the start of the experiment. Dipping with acaricide was done against external parasites.

Experimental diets were as follows:

- Diet₁ = UTRS *ad lib* + 20% *Leucaena* + 0% RB
- Diet₂ = UTRS *ad lib* + 20% *Leucaena* + 10% RB
- Diet₃ = UTRS *ad lib* + 20% *Leucaena* + 20% RB
- Diet₄ = UTRS *ad lib* + 20% *Leucaena* + 30% RB

The animals were offered with rice bran (D1 of 12 % CP) and *Leucaena* supplemented feed prior to UTRS feeding. Daily feed allowance was given in two equal proportions at 09:00 AM and 05.00 PM.

Digestibility of feedstuff

The coefficient of digestibility (COD) was calculated using the following formula for each constituent of the dry matter of the feedstuff:

$$\text{COD} = \frac{\text{Nutrient consumed} - \text{Nutrient in feces}}{\text{Nutrient consumed}} \times 100$$

Rumen degradability of feedstuff

Rumen degradation of feedstuff was determined using four cannulated adult male sheep. Residual DM, CP, and NDF values were fitted to the NEWAY computer program to determine degradation characteristics of the feed samples based on the model of Ørskov 1990 and McDonald (1981). The model describes the degradation curve as:

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

a = soluble or highly degradable fraction;
 b = slowly degradable fraction which disappears at a constant fractional rate(c);
 c = degradation rate (per h); and
 t = time (h)

The slowly degradable fraction (b) was re-estimated as $B = (a + b) - A$

Where A = actual soluble fraction (washing loss) as proposed by Ørskov and Ryle (1990)

Data collection

During the collection period, the feed offered and refused were determined daily and representative samples were also collected and analyzed for DM. Each day, about 200g of fresh *Leucaena* leaves used for feeding were also used for DM determination. The leaves from the tree of 45 days after last harvest were oven dried at 60°C for 48h. The recorded values were used to estimate feed intake. Body weight was taken for two consecutive days at 8.00 AM before feeding. The initial body weight was the average of two consecutive days. The same procedure was adopted to take the final body weight on day 91 in the morning. Initial and final body weight was recorded to determine body weight gain over the experimental period.

Fortnightly, body weight was taken in the morning before feeding to monitor the trend of weight change.

Cost and benefit analysis

Partial budget analysis was done to determine the net benefit or loss of using different level of RB in goat diet. Weight gain over the 90-day experimental period and prevailing from the price of chevon of Philippine peso 140/ kg meat was used to calculate the total return. The cost of RB at different levels was computed based on retail price of rice bran at Philippine Peso 21.5/ kg. Labor cost of offering the dietary levels was not included in the computation of cost because the difference was relatively low between diets. The following formula was used to calculate the net benefit (loss).

Net benefit (loss) = Added return – Added cost

Chemical analyses

Representative samples of feeds and refusals were subjected to DM and OM analyses following the AOAC (1990) procedure. Nitrogen content of feed samples was determined using standere procedure. Fiber fractions such as NDF, ADF, and ADL were analyzed following the method of Goering and Van Soest (1970).

Statistical analyses

Analysis of variance was conducted using the General Linear Model (GLM) by Number Crunch Statistical System (NCSS) Version 6.0. Mean comparison was done using Duncan's Multiple Range Test (DMRT).

Results and Discussion

Chemical composition of feedstuff

The chemical composition of feedstuff used in the both digestibility and feeding experiments is shown in Table 1. Urea treatment increased the CP content of the UTRS by two folds, indicating that the N was attached to the fibrous components of the straw. Other workers also reported improvement on the CP content of poor quality materials ranging from 6.7 to 14 % when ammoniation was practiced (Dolbberg *et al.* 1981, Kayouli, 1988).

A lower NDF was recorded with UTRS compared with untreated rice straw. The 54% NDF content of UTRS suggests ideal fiber content of dry roughages (Tanabe 2000). Rice bran contains 12.2 % CP, and 16.38 % NDF. On the other hand, the CP content of *Leucaena* was ideally high, 23.56 % and relatively low NDF content (Table 1).

Table 1. Chemical composition of RS, UTRS, *Leucaena*, and rice bran

Nutrients	Feedstuff			
	Rice straw	Rice bran	<i>Leucaena</i>	UTRS
Dry matter (%)	88.31	86.0	27.4	86.0
		% DM basis		
Organic matter	78.65	88.45	89.34	83.45
Crude ash	19.5	11.55	10.66	16.55
Crude protein	3.8	12.2	23.56	8.2
NDF	58.75	16.38	17.89	54.98
ADF	47.13	9.24	6.97	45.96
Hemicellulose	11.62	7.14	10.92	9.02

Source: Laboratory analysis at Philippine Carabo Center, Muñoz, Nueva Ecija, 2004.

Voluntary feed intake

The addition of 20% and 30% RB significantly increased the total DM intake but not the straw intake by the goats (Table 2). The beneficial effect of supplementation on enhancing consumption eventually resulted to higher gain among upgraded goats receiving UTRS. Similar result was observed among lambs feeding on more degradable diets brought about by the

addition to more digestible feed materials. Ørskov (1990) explained that the beneficial effect of providing greater amount of rumen degradable OM through supplementation could enhance greater microbial activity and fiber degradation that could result to higher intake on goats.

Table 2. Dry matter intake (DMI) of growing goats fed with UTRS, *Leucaena* and RB

	Diet ₁	Diet ₂	Diet ₃	Diet ₄	sig level
Dry mater intake (g/day)					
Urea treated rice straw	207.82 ^a	219.71 ^a	231.4 ^a	197.4 ^a	ns
<i>Leucaena</i> leaves	101.41 ^a	98.2 ^a	106.0 ^a	94.1 ^a	ns
Rice bran	0.0	51.18 ^c	106.1 ^b	135.6 ^a	
Total	309.23 ^b	369.09 ^{ab}	443.50 ^a	427.15 ^a	**
Dry mater Intake (g/kg W ^{0.75})					
Urea treated rice straw	31.51 ^a	31.54 ^a	29.97 ^a	27.98 ^a	ns
<i>Leucaena</i> leaves	14.00 ^a	14.08 ^b	13.6 ^b	13.2 ^b	*
Rice bran	0.0	7.42 ^c	13.65 ^b	19.14 ^a	**
Total	46.89 ^b	53.05 ^b	57.19 ^a	60.34 ^a	*
Dry mater intake (% of BW)					
Urea treated rice straw	1.664 ^a	1.660 ^a	1.520 ^a	1.414 ^a	ns
Total	2.472 ^b	2.788 ^{ab}	2.894 ^a	3.094 ^a	**

Means with common superscripts within rows are not significantly different.
Level of significance, ns = not significant (P<0.05); * P<0.05; ** P<0.001)

Table 3. Type of feed and nutrient intake by growing goats in different treatment groups

Diets	Feeds	Nutrient intake (g /day)				
		DM	CP	NDF	ADF	HEMI
Diet 1	UTRS	207.8	17.04	114.25	95.51	18.74
	<i>Leucaena</i>	101.43	23.89	18.15	7.07	11.08
	Rice bran	0.0	0.0	0.0	0.0	0.0
	Total intake	309.23	40.93	132.40	102.56	29.82
Diet 2	UTRS	219.71	18.01	120.79	100.98	19.82
	<i>Leucaena</i>	98.15	23.12	17.56	6.84	10.72
	Rice bran	51.18	6.24	8.38	4.73	3.65
	Total intake	369.04	47.37	146.74	112.55	34.19
Diet 3	UTRS	231.37	18.97	127.21	106.34	20.87
	<i>Leucaena</i>	105.88	24.94	18.94	7.38	11.56
	Rice bran	106.08	12.93	17.37	9.80	7.57
	Total	443.33	56.84	163.52	123.52	40.0
Diet 4	UTRS	197.49	16.19	108.58	90.77	17.81
	<i>Leucaena</i>	94.07	22.16	16.83	6.56	10.27
	Rice bran	135.59	16.54	22.21	12.53	9.68
	Total intake	428.15	54.89	147.62	109.85	37.77
Degradationc (fraction/h)	RS	0.018	0.04	0.017	-	-
	UTRS	0.028	0.023	0.025	-	-
	<i>Leucaena</i>	0.074	0.056	0.047	-	-
	Rice bran	0.10	0.081	0.076	-	-

Another contributory factor that could have triggered higher consumption in the D₃ and D₄ is the higher estimated solid outflow rate of the rumen digesta from the *In-situ* degradation data (Table 3). Results support the conclusion of Zhao *et al.* (1996) that one of the major effects by-product feed supplementation is increase outflow rate, with the concomitant reduction in gut retention time (MRT) and eventually leading to greater consumption. Hence, the relatively low intake among animals receiving D₁ and D₂ emphasizes the need for supplemental energy that will match the highly soluble nitrogen from UTRS to encourage adequate consumption.

Table 4. Dry matter (DM) intake, *in vivo* digestibility and digestible nutrient intake of goats fed with UTRS based diet supplemented with *Leucaena* and different level of RB

Nutrient	Diet1	Diet2	Diet3	Diet4	SigLevel
Nutrient Digestibility (%)					
DM	50.57	51.18	52.56	53.11	Ns
OM	81.42 ^b	81.67 ^b	82.79 ^a	85.74 ^a	**
CP	46.93	47.212	47.25	48.82	ns
NDF	34.02	29.92	42.66	39.47	ns
Digestible Nutrient Intake (g/ kg W ^{0.75})					
DM	24.41 ^b	26.20 ^{ab}	30.82 ^{ab}	32.02 ^a	*
OM	19.60	17.15	18.57	16.04	ns
CP	3.35	3.04	3.48	3.80	ns
NDF	7.24	6.03	9.26	7.88	ns

Mean with common superscripts within rows are not significantly different.

Level of significance, ns = not significant (P<0.05); ** P<0.01

On the other hand, RB supplementation did not result to positive increase in CP and NDF digestibility. Although, the 47 to 49% CP digestibility in D₃ and D₄ respectively were not significantly better than D₁ and D₂. Results tend to support the conclusion of Males (1987) where he reported that about 50% N from UTRS-based diets are available for digestion. The relatively low CP digestibility in D₁ suggests the need of energy supplementation to the UTRS-based diet in order to increase N availability to correct certain nutrient deficiencies.

Fiber digestibility was not affected by RB supplementation. The negative effect of higher levels of soluble carbohydrate supplementation on NDF digestibility was not observed in this study, contrary to the findings of Chowdhury (1997) where he reported

Nutrient digestibility

Table 4 presents the *in vivo* nutrient digestibility and digestible nutrient intake of growing upgraded goats fed with UTRS-based diets supplemented with different level of RB. The 20 and 30% RB inclusion resulted to significantly higher (p<0.05) OM digestibility of UTRS-based diet with *Leucaena* supplementation. Moreover, the increasing levels of RB supplementation resulted to an increasing OM digestibility, reaching 85% at 30% supplementation rate. This could be attributed to the readily-soluble carbohydrates from RB needed by microbes to enhance rumen activity (Palamquist & Jenkins). Digestibility in the rumen is a function of the fermented matter and microbial growth rates thus, with more soluble sugar in the UTRS-based diet, overall digestibility is increased.

that a RB level of more than 30%, reduced cell wall digestibility when fed to cattle. Likewise, Mgheni *et al.* (1993) earlier reported that the finding of UTRS and RB (70:30) could provide optimum rumen environment for straw degradation without necessarily affecting cell wall digestibility.

Effect on growth performance and feed conversion efficiency

The effects of different levels of RB on ADG and FCE of goats fed with UTRS + *Leucaena* is shown in Table 5 and Figure 1. Significantly higher (p<0.05) ADG of 41.11g was recorded with 20% RB supplementation. The poor performance of animals fed solely with UTRS is manifested by their lowest growth rate of 7g indicating serious lack of energy provided by the diet. As pointed out earlier, consumption of D₁ was not even enough to

support protein and energy requirement at maintenance level. With higher levels of RB inclusion, it ensured greater amount of degradable OM incorporation in UTRS + *Leucaena* diets that elicited more intake and ultimately resulted to better ($p < 0.05$) ADG beyond 20% level. This could have been due to the supplemental energy from RB that increased the proportion of easily available carbohydrates for better microbial rumen activity as suggested by Zhao *et al.* (1996). Chowdhury (1997) also observed that a higher level of RB than 30% of the diet is responsible in increasing milk yield in dairy cattle fed with cereal straw diet.

Moreover, FCE was significantly higher ($p < 0.01$) with higher RB supplementation. The result indicated that FCE could not be increased without concentrate supplementation with UTRS as basal diet among growing upgraded goats. This was first demonstrated by Mgheni *et al.* (1993) where they recorded very low FCE of 91.40g DM/kg gain among sheep fed *ad libitum* with pure UTRS diet. With greater DM intake in D3 and D4, more efficient feed utilization was recorded and consequently producing bigger and heavier animals at the end of the trial. Likewise, the higher digestibility of OM brought about by RB supplementation could have contributed to improvement of the overall feeding value of the diet.

Table 5. Live weight, growth performance, and feed conversion efficiency of growing goats fed with UTRS, *Leucaena* and different levels of RB

	Diet ₁	Diet ₂	Diet ₃	Diet ₄	Sig level
Live weight (kg)					
Initial	11.83	11.44	11.75	10.7	ns
Final	12.46 ^d	13.4 ^c	15.45 ^a	14.1 ^b	* *
Average daily gain (g/d)	7.0 ^d	21.77 ^c	41.11 ^a	37.77 ^a	**
Feed conversion efficiency (FCE)	53.22 ^a	18.56 ^b	10.96 ^d	11.30 ^c	*

Feed conversion efficiency calculated as gram total DMI per gram live weight gain per day.

Means with common superscripts within rows are not significantly different.

Level of significance, ns not significant, * $P < 0.05$

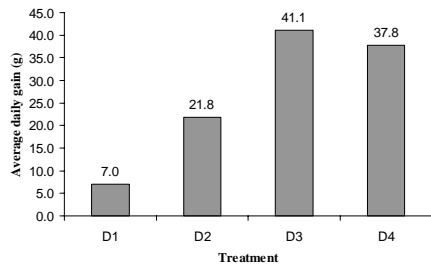


Figure 1. Average daily weight gain of growing goats

Cost and benefit analysis of rice bran supplementation

Table 6 and 7 present the cost and return, and benefit/loss of feeding different levels of UTRS to upgraded goats. The feeding of 20% RB to UTRS + *Leucaena* generated more return, amounting to US\$ 2.040 compared with the other dietary treatments. However, increasing the RB inclusion to 30% did not result to further increase in net benefit, but rather could lead to net loss of US\$ 0.875. The higher income or benefit realized in D3 is attributable to the heavier animals after the feeding trial. Result suggests that the most economical level of RB supplementation in UTRS based diet is 20% RB.

Table 6. Summary of cost and return in growing upgraded goats fed with UTRS based diet supplemented with different level of RB (Philippino Peso/ head)

Parameters	Diet ₁	Diet ₂	Diet ₃	Diet ₄	Level of sig.
Gain in dress meat (kg)	0.378 ^a	1.176 ^b	2.22 ^c	2.04 ^c	*
Marginal return (US\$)	1.005 ^a	3.128 ^b	5.905 ^c	5.426 ^d	*
Cost of rice bran	0.0 ^a	0.686 ^b	1.423 ^c	1.819 ^d	*
Net benefit	1.005 ^a	2.442 ^b	4.482 ^c	3.607 ^d	*

Means with common letters superscript are not significantly different ($P < 0.05$)

Level of significance, * $P < 0.05$

Table 7. Summary of the net benefit or loss between diets of growing upgraded goats (US\$/ head)

Parameters	Diet ₂ vs Diet ₁	Diet ₃ vs Diet ₂	Diet ₄ vs Diet ₃
Added return	111.72	146.16	0.0
Added cost	36.11	38.77	46.05
Net benefit (Loss)(US\$)	1.437	2.040	0.875

In conclusion, the inclusion of 20% RB increased total DM intake and OM digestibility of UTRS-based diet that resulted to improved ADG and FCE among upgraded goats. Growth performance revealed that 20% RB inclusion to UTRS produced heavier animals after 90 days feeding. Although there was no significant increase in straw intake and fiber digestibility, the overall quality of the diet was improved with RB supplementation. Moreover, higher income which amounted to US\$ 2.040 per animal was realized due to heavier animals at market weight when fed with UTRS supplemented with 20% RB and *Leucaena*.

In order to produce bigger and heavier animals at market, 20% RB supplementation is recommended for growing upgraded goats fed with UTRS-based diet + *Leucaena*. More efficient feed utilization can also be realized with the inclusion of more degradable OM from RB supplementation, essential in maintaining desirable rumen environment that will ensure optimum intake. Thus, higher productivity and more profitable goat enterprise can be attained with the extensive utilization of cheap and locally abundant feed resources.

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References

- AOAC. 1990. *Official methods of analysis*. (15th ed). Association of Official Analytical Chemists, Washington, DC.
- Chenost, M. and C. Kayouli. 1997. Roughages utilization in warm climates. *FAO* **135**: 1-225.
- Chodhury, S.A. 1997. Effect of graded levels of rice mill feed supplementation on intake, nutrient digestibility and microbial N yield and growth rate of native (*Bos*

indicus) bulls fed rice straw alone. *Asian-Aus. J. Anim. Aci.* **10**: 445-454.

- Dolberg, F., M. Saadullah, M. Haque and R. Haque. 1981. Storage of urea treated straw using indigenous materials. *World Animal Review* **38**:37-41.
- FAO 2000. *Production Yearbook 2000*. FAO, Rome, Itali.
- Kayouli, C. 1988. Traitement a l'uree des fourrages grossiers en milieu agricole, Report de mission. FAO du Project TCP/NER/6758.
- Males, J. R. 1987. Optimizing the utilization of cereal crop residue for beef cattle. *J. Anim. Sci.* **65**: 1124-1130.
- McDonald, I. 1981. A revised model for the estimation of protein degradability in the rumen. *J. Agric. Sci. Camb.* **96**: 251-252.
- Mgheni, D. M., A. E. Khimambo, F. Sunstol and J. Madsen. 1993. Influence of urea treatment or supplementation on degradation, intake or growth performance of goats fed rice straw diets. *Anim. Feed Sci. Technol.* **44**: 209-220.
- Murry, R. J., A. B. McAllan and R. H. Smith. 1990. *In vitro* continuous culture studies on the effect on nitrogen source of rumen microbial growth and fiber digestion. *Anim. Feed Sci. Technol.* **31**:55-64.
- Ørskov, E. R. and M. Ryle 1990. Energy nutrition in ruminants. Elsevier Applied Sci., London. pp 1-5.
- Ørskov, E. R. 2000. The *in situ* technique for the estimation of forage degradability in ruminant. *Center for Animal Breeding International*. pp. 30-32.
- Ørskov, E. R., 1990. Energy nutrition in ruminants. Elsevier Applied Sci. London. pp. 214-217.
- Rymer, C. 2000. The measurement of the forage digestibility *in vivo*. In: *Forage available in ruminant nutrition*. CAB international. pp. 113-134.
- Sahoo, A., L. C. Chaudhary, N. Agrawal, D. N. Kumar, and N.N. Pathak. 2000. Effect of feeding different ratio of grass fodder and straw supplemented with wheat bran on the performance of male crossbred calf. *Asian Aust. J. Ann. Sci.* **13** (1): 19-22.

- Sharma, D. D., D. V. Rangnekar and M. Singh. 1995. Physical and chemical treatment of fibrous crop residue to improve nutritive value. *In: A review on fibrous crop residues*. NDRI, India. pp. 263-276.
- Tanabe, S. 2000. *Quality criteria of feed. Technical manual for feed analysis*. Japan Livestock Technology Association. Japan. pp. 73-76.
- Umunna, N. N., P. O. Osuji, H. Khalili, I. V. Nsahlai and S. Crosses. 1995. Comparative feeding value of forage from two cereal legumes based cropping system for beef production from cross bred (*Bos taurus* x *Bos indicus*) streer and subsequent performance of underfed and realimented streer. *Animal Science* **61**: 35-45.
- Zhao, Y., K. Taniguchi and T. Obitsu. 1996. Effect of by-product diets containing rice bran and beet pulp on the site and extent of digestion and microbial synthesis in deer. *Asian-Aust. J. Anim. Sci.* **10**: 215-222.