

## Effects of bermuda grass (*Cynodon dactylon* cv. *Coast cross*) and rice hulls on growth performance of 30 day-old weaned rabbits

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**SUMMARY.** Several studies have demonstrated that rabbits can be maintained on diets containing high levels of Crude Fiber (CF) when compared to other monogastric animals. In the present study, we examined the effects of rice hulls and of bermuda grass (cv. *Coast cross*) on the growing performance of 30 day-old weaned rabbits. Rabbits were fed one of 5 diets containing rice hulls and/or bermuda grass as fiber source at the following proportions (BG/RH) 0/17.5, 15/11, 0/29, 14.7/19.1 and 48.5/0 for diets A, B, C, D and E, respectively. Body weight gain and voluntary feed intake were measured at 30, 44, 58 and 72 days. The time necessary to attain 2 kg of live body weight was not affected by the diets. However, daily weight gain differed significantly during the first two weeks after weaning among dietary groups. Diets C and D caused a lower body weight gain, probably because of the high level of Acid Detergent Fiber (ADF) in the diet (24% and 23%). Voluntary feed intake increased with age in all treatments, but food intake was lower in treatments C and D when compared to animals receiving treatments B and E. The present results demonstrate that when rice hulls are used as fiber source, fiber must be given as ADF and not as CF because the difference between ADF and CF is enormous. Rice hull-containing diets balanced with CF give an inappropriate amount of components that seem to affect the growth performance of young animals.

**RESUMEN.** Efectos de la hierba bermuda (*Cynodon dactylon* cv. *Coast cross*) y de la cáscara de arroz en el crecimiento de conejos destetados con 30 días de edad. Varios estudios demostraron que los conejos pueden ser mantenidos en dietas conteniendo niveles altos de fibra cruda (FC) cuando son comparados con otros monogástricos. En este estudio examinamos el efecto de la cáscara de arroz y de la hierba bermuda en el desarrollo de conejos en crecimiento, destetados con 30 días de edad. Los conejos fueron alimentados con 5 dietas, que contenían hierba bermuda (HB) y cáscara de arroz (CA), como fuente de fibra, en la siguiente proporción (HB/CA): 0/17.5, 15/11, 0/29, 14.7/19.1 y 48.5/0 en dietas A, B, C, D y E, respectivamente. Se midió la ganancia de peso y la ingestión voluntaria de comida a los 30, 44, 58 y 72 días. El tiempo necesario para alcanzar 2 kilos de peso de cuerpo vivo no fue afectado por las dietas. Pero el aumento de peso diario difirió significativamente en las dos primeras semanas después del destete entre los grupos dietarios. Las dietas C y D causaron un pequeño aumento de peso, probablemente por causa del nivel alto de Fibra Acido-detergente (FAD) en las dietas (24% y 23%). La ingestión voluntaria de comida aumentó con la edad en todos los tratamientos, pero los tratamientos C y D se presentaron menores en comparación con los animales de los tratamientos B y E. Los resultados del presente estudio demuestran que cuando la cáscara de arroz es usada como fuente de fibra, la fibra a administrar debe ser dada como FAD y no como FC ya que las diferencias entre FAD y FC son enormes. El uso de FC causa un nivel inapropiado de componentes no digeribles que afectan el desarrollo del crecimiento en animales jóvenes.

### INTRODUCTION

Rabbits are nonruminant herbivores that can consume an elevated quantity of plant cell walls when compared to other monogastric animals and that can use nutrients fermented in the hindgut (caecum) through caecotrophy. The microbial breakdown of cellulose-containing foodstuffs in the caecum

of rabbit produces volatile fatty acids that may contribute up to 30% of daily energy requirements of this animal (1,2). Furthermore, rabbits can obtain vitamins, mainly of the B complex, through the ingestion of soft feces (3). Thus, the Crude Fiber (CF) levels in the diet can be higher than for other monogastric animals (4). Furthermore, the adequate rate of digesta passage seems to be influenced by fiber content and

various investigators have demonstrated that low fiber contents are associated with digestive disorders in rabbits (5, 6, 7, 8).

Due to this capacity, rabbits can be raised on diets containing a relatively high roughage content and consequently avoid competition with man, swine or poultry for the consumption of cereals and legumes. Based on this fact, it was suggested that rabbits should play an important role as protein sources for rural households, mainly in developing countries (9).

Although various lines of evidence suggest that forage can be used as fiber source in diets for growing rabbits (10, 11, 12, 13, 14, 15), the majority of studies used alfalfa (*Medicago sativa*) for this purpose (5, 16, 17, 18, 19). However, in our country, alfalfa is an expensive product for inclusion in commercial rabbit diets (12). Recently, Coastal bermuda grass (*Cynodon dactylon cv. Coastal*) was used as fiber source in diets for growing rabbits (20). The authors concluded that Bermudagrass was not adequate as fiber source because it depressed rabbit growth. Other authors have used rice hulls as a fiber source for growing rabbits (21,22) and concluded that live weight gain was high when 10 to 20% rice hulls were used as the main fiber source of the diets.

Few studies have assessed the early response of rabbits to different fiber sources. This aspect seems to be of great importance, since the gradual transition from milk to ration intake may be accelerated by weaning and consequently under some circumstances the digestive tract of young animals may be not completely developed to receive diets with high fiber contents (4). Champe and Maurice (20) suggested that early weaned rabbits were more susceptible to the deleterious effects of Coastal Bermudagrass or low fiber diets. Since few studies have examined the early response of young rabbits to different fiber sources, we investigated the separate and combined effects of two different fiber sources (bermuda grass cv. Coast cross and rice hulls) on live weight gain and feed intake of young rabbit. The Coast cross variety of bermuda grass is of greater digestibility for ruminants than the Coastal variety (23), and probably would provide an adequate source of fiber for growing rabbits. Rice hull were used as a fiber source because of the increasing use of this component in commercial diets for rabbits in Brazil.

#### MATERIAL AND METHODS

Thirty one New Zealand white rabbits (30-35 days old) of both sexes, were used. Rabbits were housed individually in wire-bottomed cages. Feed was offered in an earthenware container (10 cm high x 20 cm diameter). Wire was fastened to form a cross at two different levels about 4 cm apart to avoid food selectivity.

Each animal was fed *ad libitum* one of the 5 diets whose composition and chemical analysis are shown in Table 1. Bermudagrass hay was prepared by cutting the grass at the onset of flowering, drying in the sun and then wrapping in bundles. All ingredients were milled using a Penha H-5000

model mill (Brazil) with a 2 mm<sup>2</sup> mesh. Basically the diets contained rice hulls (RH) or bermudagrass (BG) as fiber source at the following proportions (BG/RH): 0/17.5 (treatment A), 15/11 (treatment B), 0/29 (treatment C), 14.7/19.1 (Treatment D) and 48.5/0 (treatment E). The CP, CF and ADF contents of bermudagrass were (in g/kg of dry matter) 118.4, 330.7 and 402.8, respectively. For rice hulls these values were 18 (but this was not considered for balancing the diets that appear in Table 1), 365.9 and 657.6, respectively Rabbits had free access to water.

TABLE 1  
INGREDIENT AND CHEMICAL COMPOSITION OF  
EXPERIMENTAL DIETS (g/kg)

Diets	A	B	C	D	E
Ingredients					
Bermudagrass hay	0	150	0	147	485
Rice hull	175	110	290	196	0
Corn	510	442	350	294	156
Soya flour	220	206	270	276	272
Soyabean oil	70	70	70	70	70
Mineral and vitamin	25	25	25	25	25
SUM	1000	1003	1005	1009	1008
Chemical composition					
Crude fiber	88	112	136	148	183
Acid detergent fiber	158	172	240	230	214
Crude protein	167	172	185	197	219
Ash	99	95	120	113	98
ADF-CF (g/kg)	70	60	104	82	31

Mineral composition (mg/kg dry matter of diet): 6990 NaCl; 4500 bone meal; 1010 KCl; 2505.1 MgSO<sub>4</sub>.6H<sub>2</sub>O; 93 FeSO<sub>4</sub>.7H<sub>2</sub>O; 52.5 MnO; 43.2 ZnO; 3.2 CoCl<sub>2</sub>; 0.4 CuSO<sub>4</sub>; 0.33 KIO<sub>3</sub>; 0.12 SeO.  
Vitamin composition: 7.500 IU vitamin A; 2.000 IU vitamin D<sub>3</sub>; 2.5 IU vitamin E; 5.0 mg nicotinamida; 2.0 mg vitamin B<sub>1</sub>; 1.0 mg vitamin B<sub>6</sub>; 0.75 mg riboflavin phosphate; 2.4 ug vitamin B<sub>12</sub>; 4 mg calcium pantothenate acid and 300 mg choline.

Diets A,B,C, and D were fed to groups of 6 rabbits each (3 males and 3 females) and diet E was fed to 7 rabbits (3 males and 4 females). Body weight gain and food intake were measured weekly for 6 weeks.

The chemical composition of the diets was determined by the method of Van Soest (24) for Acid Detergent Fiber and according to the AOAC for Crude Protein, Crude Fibre and Ash (25).

Body weigh gain data were initially analyzed by three-way ANOVA (5 (diets) x 2 (sex) x 4 (age), but since sex had no

significant effect, data for males and females were pooled and a 5 (diets) x 4 (30,44, 58 and 72 days of age) ANOVA was calculated with the age factor treated as repeated measures (26) were conducted. Data for feed conversion rate and food intake were initially analyzed by a three-way ANOVA considering the sex factor, but since no sex effect was observed data were pooled and analyzed by a 5 (diets) x 3 (sampling time) ANOVA with the sampling time factor treated as repeated measures (26). The absence of a sex effect on the measured parameters in growing rabbits is in accordance with literature data (18,27).

## RESULTS

The effects of diets on daily body weigh gain, feed conversion rate and daily food intake are shown in Table 2. Two way ANOVA of daily body weigh gain demonstrated that the diets had no significant effect on total body weight gain ( $F(4,26)=1.51$ ,  $P=0.227$ ), but yielded a significant diet x age interaction ( $F(12,78)=3.42$ ,  $P<0.01$ ) and also a significant effect of age ( $F(3,78)=719.22$ ,  $P<0.001$ ). The interaction was significant because during the first two weeks after weaning animals maintained on diets containing 29% rice hulls (treatment C) and 15% bermudagrass with 19% rice hulls (treatment D) grew significantly less than rabbits maintained on the other treatments (Duncan's multiple-range-test,  $P<0.05$ ).

TABLE 2  
EFFECT OF TREATMENTS ON DAILY BODY  
WEIGHT GAIN AND VOLUNTARY  
FEED INTAKE AS A FUNCTION OF AGE (g/d)

Diet	Dat 30 to 44	Day 45 to 58	Day 59 to 72	Total body weight gain (g)
A	24.00 a	22.8	25.3	1010.00 a
B	22.50 a	23.1	27.5	1030.00 a
C	12.55 b	20.3	24.2	812.86 b
D	12.86 b	19.6	18.9	719.17 b
E	21.65 a	24.8	23.9	986.25 a
	Daily live weight gain*			
	Voluntary feed intake**			
			Total Voluntary Food Intake (g)	Feed Conversion Rate
A	67.7 ab	79.1 ab	76.8	3129.4 ab
B	51.2 bc	83.6 a	95.0	3217.0 a
C	45.3 c	64.3 bc	72.3	2546.9 bc
D	41.9 c	58.4 c	65.4	2320.0 c
E	72.3 a	83.2 a	92.7	3475.4 a

\*, \*\* means in the same row that do not have a common superscript differ ( $P<0.05$ ).

The statistical analysis of food intake revealed a significant main effect of diets ( $F(4,26)=5.77$ ,  $P<0.01$ ) and post-hoc comparisons by Duncan's test demonstrated that rabbits in treatments C and D showed a low food intake when compared to animals in treatments B and E. ANOVA also revealed a significant effect of sampling time and the F-test on simple effect demonstrated that rabbits in all groups increased their food intake as a function of age ( $P<0.01$ ).

The analysis of feed conversion rate revealed only a significant diet x time sampling interaction ( $F(8,56)=2.44$ ,  $P<0.025$ ) and post-hoc comparisons demonstrated that the feed conversion rate of rabbits in treatment E was significantly higher than that of treatments A and C (Duncan's multiple range test,  $P<0.05$ ) from day 59 to 72.

## DISCUSSION

The main objective of the present study was to examine the effect of different fiber sources on the growth of weanling rabbits. Rabbit growth was influenced by treatments mainly during the first two weeks after weaning. During this period, body weight gain was lower in rabbits maintained on diets C and D when compared to those observed in animals on the other diets. The levels of CF of these 5 diets ranged from 8.8% (treatment A) to 18.3% (treatment E) and appear to be within an adequate range for growing rabbits (7). Furthermore, CF levels cannot exclusive account for the worse performance observed in rabbits in treatments C and D (Table 2), since the CF levels of treatment E were higher than those of diets C and D. Probaly the factor responsible for the poor body weight gain by rabbits on diets C and D was the ADF content. According to De Blas (7), weight gain remains high for ADF levels between 12.6 and 24.6%. However, from 20% ADF onwards, a linear decrease in daily body weight gain is observed. Thus, ADF levels were 3 to 4 units higher than the limit for an adequate weight gain in treatment C and D, but only one unit higher in treatment E. The results obtained with treatments A and B demonstrate that when the ADF levels of diets were lower than 20% rice hulls alone or in association with bermudagrass could be used as an adequate fiber source for growing rabbits.

Another important factor that may have influenced the performance of young rabbits is the content and quality of dietary protein. Diets A and B had the more appropriate protein quality, because their soy flour and maize content was close to the optimum nutritional ratio (30/70) when compared to diets C and D. Thus, in addition to ADF levels, protein quality (especially sulfur amino acid deficiency) may have contributed to the worse performance of rabbits in groups C and D. However, some data did not fully support this interpretation. First, diet E which had the worst soy flour to maize ratio (approximately 120/70) gave results similar to diets A and B. In relation to sulfur amino acids, diet E probably was the most deficient, since grasses generally are poor in

sulfur amino acids (28). A possible explanation to the absence of an apparent effect of protein quality on rabbit performance may reside in cecotrophy. Several lines of evidence support the notion that rabbits are relatively insensitive to the protein quality of the diet, because part of the essential amino acids may be provided through soft feces intake (9,16). Another possibility that should be considered here is the fact that fiber (in the present case ADF) can reduce the digestibility of organic matter of rabbit diets (27). Thus in diets C and D, the high level of ADF could have impaired the digestibility of some important diet component.

One important aspect observed in the present investigation was the early response of weaned rabbits to diets containing different levels of ADF. The results suggested that the deleterious effect of a high ADF content was more marked soon after weaning and seemed to decrease at subsequent measurements. This may indicate that young rabbits were more sensitive to poor-quality fiber sources, in agreement with observations made by other investigators (20,27). However, more detailed studies are necessary to verify the influence of ADF from sources other than bermudagrass and rice hulls on the growth of young rabbits, especially in the first weeks after weaning.

Maertens (29) suggested that equations based on ADF level did not give better estimation than the use of CF contents. This cannot be held as a general rule for balancing rabbit diets. It appears to be interesting to use ADF levels to determine the maximum allowable level of fiber in the diet, mainly when fiber sources have great differences in ADF to CF contents like rice hulls (ADF-CF=291.7 g/kg). Thus, one important practical aspect that became apparent from this study was the fact that when rice hulls are used as a fiber source, the cell wall components must be given as ADF and not as CF values, which is the common commercial practice in Brazil.

On the basis of the results obtained in this work, further studies are necessary to stipulate an age band for rabbits, considering the components of fiber source used from weaning to slaughter.

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