

BALANCE OF N OF YOUNG MONG CAI AND LARGE WHITE PIGS. HIGH FIBROUS DIETS BASED ON FULL-FAT RUBBER SEEDS

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SUMMARY

Eight Large White and Mong Cai castrate male pigs of approximately 20 kg were allocated at random in two treatments according to a two-period balanced change over design to study the effect of full-fat rubber seed meal (FFRS) on the balance of N and nutrient digestibility at the rectum site. The diets were formulated to contain 18% crude protein and dietary wheat bran was substituted by 0 and 20% FFRS (N 2.23, NDF 61.40, crude fibre 54.88, ether extract 13.65% in dry basis respectively and cyanide 28 mg/kg DM).

There was no significant effect of period ($P>0.05$) in any measurement. There was no significant ($P>0.05$) interaction genotype x diet interaction in any case. A significant ($P<0.01$) effect was found of FFRS to decrease DM, organic matter and NDF digestibility. This effect was not significant for crude fibre, NFE, ether extract and N digestibility. On comparing both genotypes, Large White pigs appeared to digest several nutrient fractions of the diet more efficiently than Mong Cai pigs, but this effect was only a trend ($P<0.10$). Mong Cai significantly ($P<0.01$) digested better the ether extract and NDF fraction of the diet. N balance was significantly ($P<0.001$) better when FFRS were introduced in the diet, and was better ($P<0.01$) in Large White than in Mong Cai pigs.

It appears that N balance is not affected in pigs fed 20% FFRS in the diet when fresh water dry fish is used as the other protein source of the diet. It is probable that differences in rectal digestibility amongst Mong Cai pigs and improved breeds are small, but evident. An exception is rectal digestibility of ether extract which is better in Mong Cai animals. In contrast, N balance in improved pigs appears to be more efficient than in the Mong Cai genotype. According to the information obtained in the current investigation, it should be useful to determine in future experiments, the N requirements of Mong Cai pigs, and to use energy rich, in situ available feedstuffs such as rubber seeds for feeding local pigs such as Mong Cai animals, which exhibit advantages in digestive utilization of fat.

Key words: pigs, Mong Cai, genotype, full-fat rubber seed, balance of N, rectal digestibility, in vitro digestibility

Short title: Rubber seed digestibility in Mong Cai pigs

BALANCE DE N EN CERDOS JÓVENES MONG CAI Y LARGE WHITE. DIETAS ALTAS EN FIBRA BASADAS EN SEMILLAS DE CAUCHO SIN DESGRASAR

RESUMEN

Se distribuyeron en dos tratamientos al azar ocho cerdos Large White y Mong Cai machos castrados de aproximadamente 20 kg de acuerdo con un diseño de cambio balanceado con dos períodos para estudiar el efecto de las semillas de caucho sin extracción de aceite (SCCA) en el balance de N y la digestibilidad de nutrientes a nivel del recto. Las dietas se formularon para contener 18% de proteína cruda y el afrecho de trigo dietético fue sustituido por 0 y 20% de SCCA (N 2.23, FDN 61.40, fibra cruda 54.88, extracto etéreo 13.65% en base seca respectivamente, y cianuro 28/kg MS).

No hubo efecto significativo del período ($P>0.05$) en ninguna medida. No hubo interacción genotipo x dieta significativa ($P>0.05$) en ningún caso. Se halló un efecto significativo ($P<0.01$) de la SCCA para disminuir la digestibilidad de la MS, materia orgánica y FDN de la dieta. Este efecto no fue significativo para la digestibilidad de la fibra cruda, el ELN, el extracto etéreo y el N. Al comparar ambos genotipos, los cerdos Large White parecieron digerir más eficientemente distintas fracciones de nutrientes dietéticos en contraste con los Mong Cai, pero este efecto fue solamente una tendencia ($P<0.10$). Los cerdos Mong Cai digirieron significativamente mejor el extracto etéreo y la fracción de FDN de la dieta. El balance de N fue significativamente mejor cuando la SCCA se introdujo en la dieta y fue mejor ($P<0.01$) en los cerdos Large White que en los Mong Cai.

Aparentemente el balance de N no se afecta con 20% de SCCA en la dieta cuando se usa pescado desecado de río como la otra fuente de proteína en la dieta. Es probable que las diferencias en digestibilidad rectal entre cerdos Mong Cai y los de razas mejoradas sean pequeñas, pero evidentes, salvo en lo referente a la digestibilidad rectal del extracto etéreo que favorece a los Mong Cai. En contraste, el balance de N en los cerdos mejorados parece ser más eficiente en los cerdos mejorados que en los Mong Cai. The acuerdo con la información obtenida en esta investigación, sería útil determinar en futuros experimentos, los requerimientos de N de cerdos Mong Cai, y usar alimentos ricos en energía disponibles in situ, tal como lo son las semillas de caucho, para alimentar cerdos locales del tipo Mong Cai, que exhiben ventajas en la utilización digestiva de la grasa.

Palabras claves: cerdos, Mong Cai, genotipo, semillas de caucho, balance de N, digestibilidad rectal, digestibilidad in vitro

Título corto: Digestibilidad de semillas de caucho en cerdos Mong Cai

INTRODUCTION

Rubber seed utilization by pigs can be of interest in those countries where rubber tree plantations are one of the industrial crops of high economical importance (Perez 1997). In this connection it has long time been claimed that rubber seeds production might be taken into account as a feed for livestock (Fetuga et al 1977; Hutagalung 1981; Ong and Yeong 1978). Cambodia is not one of the outstanding countries from the South East Asia where rubber trees are largely cultivated (FAO 1999). However, it is expected that in the near future areas for rubber trees cultivation should be in continuous increase.

Significant amounts of whole rubber seeds as a protein source could be of positive influence in the diets of monogastric animals, since the low nutritive value of a high proportion of cell wall fractions contained in the husk (Narahari and Kothandaraman 1984, Nwokolo 1987) could be largely compensated by the availability of the fat fraction present in the kernel (Ly et al 2001; Pok Samkol et al 2002). On the other hand, there is scanty information considering the use of full fat rubber seed as feedstuff to be used in pig production, either ground (Nguyen Thi Thuy and Ly 2002) or as cake (Madubuike et al 2006).

Very few is known in relation to nutrient utilization by Mong Cai pigs in comparison with other improved breeds. In this connection, there are some suggestions that a trend exists of Mong Cai pigs to make a better utilization of the cell wall fractions of the diet in comparison with Large White animals, and that, in turn, Large White pigs have a better balance of N if compared to the Mong Cai genotype. The first of the above mentioned hypothesis appears not to be clear in contrast to the second one (Chiev Phiny et al 2002; Nguyen Thi Thuy and Ly 2002; Ly et al 2003; Len et al 2006).

In a previous experiment (Ly et al 2003), information was provided concerning the digestion by pigs of a fibrous diet containing a high proportion of wheat bran. One objective of the experiment reported herein was to further compare digestive utilization and N balance in pigs of diets containing a high proportion of wheat bran or wheat bran partially substituted by whole, full-fat rubber seeds. Another objective was to obtain more information about the digestive ability of Mong Cai and Large White breeds.

MATERIALS AND METHODS

The experiment was conducted with a total of eight Large White and Mong Cai castrate male pigs of approximately 20 kg allocated at random according to breed into a two-period change over design (Gill and MacGee 1976; Gill 1978) to study the effect of full-fat rubber seeds (FFRS) on the balance of N and rectal nutrient digestibility indices. The diets were formulated to contain approximately 18% crude protein (table 1) and dietary wheat bran was substituted by 0 and 20% FFRS (DM 82.50%, and in dry basis, N 2.23, NDF 61.40, crude fibre 54.88 and ether extract 23.65% respectively). The cyanide content of a representative sample of the batch of FFRS used in the trial revealed a content of 28 mg/kg DM.

In this experiment diet composition was equivalent to that used by Bun Tean et al (2002). Mong Cai animals were from a herd

of the Centre, and were originated from other Vietnamese herd which was kept at the University of Agroforestry, Ho Chi Minh City. Rubber seeds were obtained from a Cambodian rubber trees plantation.

Table 1. Details of the diets (percentage in dry basis)

Ingredients	Full-fat rubber seeds, %	
	-	20
Wheat bran	94.0	74.0
Fresh water dry fish	5.0	5.0
Full-fat rubber seeds	-	20.0
NaCl	0.5	0.5
Vitamins and minerals ¹	0.5	0.5
Analysis		
DM	88.02	86.97
Ash	6.14	5.56
Organic matter	93.86	94.44
NDF	30.84	36.95
Crude fibre	9.70	18.62
Ether extract	2.10	4.41
NFE	64.01	53.36
Nx6.25	18.05	18.05
Energy, kjoule/g DM	17.94	18.85
Wash value, % ²	50.5	48.2
WHC, g H ₂ O/g DM ³	4.85	6.15

¹ According to NRC (1998) requirements for vitamins and trace elements

² See Ly and Preston (2001)

³ Water holding capacity (WHC) was determined according to Tsaras et al (1998). See text

Every animal was housed in metabolism cages as those designed by Chiv Phiny and Rodríguez (2001). The diets were offered to the pigs as a meal at a rate of 35 g DM/kg body weight. Every experimental period consisted of 10 days, divided into two aequal five-day periods of adaptation and quantitative collection of feed refusals, feeds and urine (Ly et al 2001). Details concerning housing and daily work routine have been already described (Ly et al 2001). As alternative, in this experiment, aliquotes from faeces were collected at 12:00 m and 4:00 pm, conveniently pooled and sent to the laboratory in order to avoid a long stay of faeces under the metabolism cage. This procedure was repeated during five successive days, with independence of the daily quantitative collection of faeces from every pig.

Samples of food and faeces were analyzed for DM by microwave radiation (Undersander et al 1993), ash, crude fibre and N according to the Association of Official Analytical Chemists (AOAC 1990). N content in faeces and urine was determined in materials in natura. The filtration alternative of Tsaras et al (1998) as undertaken by Ly et al (2003) was choose for the measurement of water holding capacity (WHC) of the samples. The wash value of the feeds was determined in a washing machine following recommendations of Ly and Preston (2001). NDF analyses were conducted following Van Soest et al (1991) whereas acidified ether extract in faeces was determined according to Ly et al (1990). The calorific content of feeds and faeces was estimated from the following

Nehring and Haenlein (1973) equation, expressed in kcal/100 g DM:

$$y = 5.72 k_1 + 4.79 k_2 + 9.50 k_3 + 4.03 k_4$$

where k_1 , k_2 , k_3 and k_4 corresponded to crude protein, crude fibre, ether extract and NFE content of the samples, in percent..

All analyses were conducted by duplicate.

Four representative samples from every batch of wheat bran, FFRS and fresh water dry fish used in the balance trial were obtained for in vitro (pepsin/pancreatin) digestibility determination according to Dierick et al (1985). Casein of analytical grade was employed as protein standard.

Analyses of variance were conducted according to a standard technique (Steel et al 1997). In the cases where it was necessary, the Duncan multiple range test was employed. The Minitab software (Ryan et al 1992; Minitab 2000) was used in the biometrical manipulation of data.

RESULTS

There was any symptom of cyanide intoxication in the pigs. All animals appeared in good health and during the duration of the trial (20 days), average daily gain of pigs was 340 g. there was no significant ($P>0.05$) effect of period on any of the parameters studied. Therefore the data were analyzed according to a factorial arrangement 2 x 2 with four replications per treatment. In this case, there was no significant ($P>0.05$) interaction genotype x diet in the evaluated measurements.

The effect of genotype on rectal digestibility of nutrients is shown in table 2.

Table 2. Rectal digestibility of pigs fed wheat bran and full-fat rubber seeds. Effect of genotype

	Genotype		SE ±
	Large White	Mong Cai	
n	8 ¹	8	-
Digestibility, %			
DM	74.9	72.4	1.9 ⁺
Organic matter	76.9	75.1	1.9 ⁺
Crude fibre	34.5	39.9	7.1
NDF	52.8	57.0	2.4*
Ether extract	72.7	88.0	3.5***
NFE	92.5	89.5	2.0
Energy	78.4	76.0	2.5

¹ Two observations per animal

⁺ $P<0.10$; * $P<0.05$; *** $P<0.001$

On comparing both genotypes, Large White pigs appeared to digest several nutrient fractions of the diet more efficiently than Mong Cai pigs, but this effect was only a trend ($P<0.10$) for DM and organic matter digestive utilization. On the other hand, Mong Cai animals significantly digested better the ether extract ($P<0.001$) and NDF ($P<0.05$) fraction of the diet.

Results concerning the effect of rubber seeds in the digestive use of diets are presented in table 3. The introduction of rubber seeds in the diet determined a significant ($P<0.05$) decrease in

rectal digestibility of DM, organic matter and energy. A similar, non significant influence was noted for crude fibre and NDF digestibility. However, FFRS in the diet appeared to increase, although not in a significant ($P>0.10$) manner, NFE and ether extract rectal digestibility.

Table 3. Rectal digestibility of pigs fed wheat bran and full-fat rubber seeds. Effect of diet

	FFRS, % ¹		SE ±
	-	20	
n	8 ¹	8	-
Digestibility, %			
DM	75.9	71.3	2.4*
Organic matter	78.1	73.8	2.4*
Crude fibre	39.3	34.2	5.1
NDF	58.7	51.0	2.9*
Ether extract	80.4	84.3	3.5
NFE	90.8	91.2	2.0
Energy	79.0	75.4	2.4*

¹ Full-fat rubber seed

² Two observations per animal

* $P<0.05$

Nutrient digestibility of FFRS as calculated by difference (Crampton and Harris 1969), revealed that DM, organic matter and energy digestibility at the rectal site were quite similar (52.90, 56.60 and 61.00% respectively). In this connection, a rather low digestive utilization for crude fibre, NDF and NFE was noted (13.80, 20.40 and 64.10% respectively). An outstanding data was ether extract digestibility of FFRS, which was calculated to be 99.9%.

A clear evidence for a major N digestibility ($P<0.10$), as well as N retention, either expressed in g/day ($P<0.05$) or as percentage of consumption and digestion ($P<0.001$), was evident, Mong Cai pigs utilizing less efficiently the dietary N than Large White pigs (table 4).

Table 4. N balance of pigs fed wheat bran and full-fat rubber seeds. Effect of genotype

	Genotype		SE ±
	Large White	Mong Cai	
n	8 ¹	8	-
Balance, g/day			
Intake	20.15	19.85	0.16
Faecal excretion	3.71	4.25	0.27
Digestion	16.44	15.60	0.35 ⁺
Digestibility, %	81.6	78.6	1.9 ⁺
Urinary excretion	6.57	7.60	0.73
Total excretion	10.28	11.85	0.45
Retention	9.87	8.00	0.55*
Retention:intake	49.0	40.3	2.7***
Retention:digestion	61.1	50.3	3.4***

¹ Two observations per animal

⁺ $P<0.10$; * $P<0.05$; *** $P<0.001$

It appeared that N balance was better when FFRS were introduced in the diet of pigs in terms of either daily g of N retained per pig, or as percent of that consumed or digested. Details related to this balance are listed in table 5. Nevertheless, this trend was found not to be significant ($P>0.10$).

Table 5. N balance of pigs fed wheat bran and full-fat rubber seeds. Effect of diet

	FFRS, % ¹		SE ±
	-	20	
n	8 ¹	8	-
Balance, g/day			
Intake	20.05	19.95	0.10
Faecal excretion	3.99	3.99	0.15
Digestion	16.06	15.96	0.20
Digestibility, %	80.1	80.0	1.45
Urinary excretion	7.36	6.78	0.56
Total excretion	11.35	10.77	0.60
Retention	8.70	9.18	2.7
Retention:intake	43.4	46.0	4.2
Retention:digestion	55.6	56.4	5.3

¹ Full-fat rubber seed

² Two observations per animal

The in vitro digestibility (pepsin/pancreatin) of the dietary component is shown in table 6. It was found that samples of fresh water dry fish exhibited a higher ($P<0.001$) in vitro DM and organic matter digestibility than either FFRS or wheat bran. On the other hand N utilization was similar between FFRS and the fish sample, with significantly ($P>0.001$) lower values for wheat bran. In the case of the in vivo N estimation by difference, FFRS revealed to show a relatively high rectal digestibility (79.60%).

Table 6. In vitro (pepsin/pancreatin) digestibility of the feed ingredients¹

	In vitro digestibility, %		
	DM	OM	N
n	4	4	4
Ingredients			
Wheat bran	55.5 ^b	60.2 ^b	58.7 ^b
Full-fat rubber seeds	45.1 ^c	50.3 ^c	70.3 ^a
Fresh water dry fish	65.4 ^a	72.0 ^a	75.4 ^a
SE ±	3.9 ^{***}	4.5 ^{***}	3.0 ^{***}

¹ In vitro DM digestibility for casein was $98.5 \pm 0.5\%$

*** $P<0.001$

^{abc} Means without letter in common in the same column differs significantly ($P<0.05$) among them

DISCUSSION

The nutritional value of full-fat rubber seeds for pigs

Data herein presented further support the idea that rubber seeds are a source of protein to be considered in those regions where rubber tree plantations are abundant, as it has been suggested (Hutagalung 1981; Pérez 1997 among others). On the other hand, a relatively efficient crude fat digestibility is another aspect to be taken into account.

It has been suggested that N balance in pigs fed graded levels of whole rubber seed in the feed is not impaired (Bun Tean et al 2002). In addition, data from a short-term growth experiment strongly indicated that performance traits of pigs fed 27% of rubber seeds where not impaired (Nguyen Thi Thuy and Ly 2002). In this connection, it has been found inconsistency in results obtained from several digestibility experiments approaching the nutritive value of rubber seeds in our laboratory (Ly et al 2001, Bun Tean et al 2002; Nguyen Thi Thuy and Ly 2002); Pok Samkol et al 2002). However, results herein presented strongly reinforce the idea that the nutritive

value of full-fat rubber seeds must be taken into account for feeding pigs, in spite of its high content of fibrous materials. This idea is supported too by on one hand, the in vitro (pepsin/pancreatin) digestibility data of full-fat rubber seeds and by those data provided by Buy (2003) from ileal digestibility of partially defatted rubber seeds given in Vietnam to young animals, and on the other hand, by the high digestibility of the ether extract and N fraction of the seeds.

It is possible that less digestion of fibre fractions in the large intestine of pigs fed on FFRS (this experiment) together with a higher microbial metabolite output in faeces (Ly and Pok Samkol 2008), could be related to a lower retention time of digesta in the caecum and colon of animals. In this respect, Buy (2003) observed a decreased large intestine contribution to overall fibre fractions digestibility when pigs were fed 30% rubber seed oil meal.

Rectal digestibility and N balance in Mong Cai pigs

The present investigation provides further evidences that differences exist between Mong Cai and some improved breeds of pigs such as Large White, from the point of view of nutrient digestibility at the rectal site (Chiev Phiny et al 2002; Nguyen Thi Thuy and Ly 2002; Ly and Pok Samkol 2002). These findings are in accordance to others from Borin Khieu et al (2005) and Len et al (2006) too. In this connection it is worthy to note the very remarkable ability of Mong Cai pigs to digest better two so different types of dietary fractions, as there are cell walls and ether extract. In this connection it appears that differences and similitudes do exist between local breeds of pigs. As illustration, Cuban Creole pigs are unable to digest fibre fractions with an acceptable efficiency, but this genotype is very well adapted for digestion of the fat fraction of diets (Ly et al 2002). Other Iberian related pig, the Alentejano genotype, does digest dietary fibre and fat fractions with advantages over improved breeds (Freire et al 1998). Besides, both Iberian related genotypes are not efficient from the point of view of N utilization (Freire et al 1998; Ly et al 2002).

On the other hand, it is probable that differences in rectal digestibility among Mong Cai pigs and improved breeds are small, but evident. In contrast, N balance in improved pigs appears to be more efficient than in the Mong Cai genotype. The poor N utilization of this local, unimproved breeds of pigs should be explained by its slow growth rate (Nguyen Thi Thuy and Ly 2002) and body composition, which is otherwise characterized by a high degree of fatness (Molenat and Tran 1991). In this connection, it could be expected that N requirements of Mong Cai pigs, and therefore essential amino acids, would be lower than that suggested for highly improved breeds of animals (NRC 1998).

According to the information obtained in the current investigation, it should be useful to determine in future experiments, the N requirements of Mong Cai pigs, and to use energy rich, in situ available feedstuffs such as rubber seeds for feeding local pigs such as Mong Cai animals, which exhibit advantages in digestive utilization of fat.

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