Developing diets for collared peccary (*Tayassu tajacu*) from locally available food resources in Bahia, Brazil

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Abstract

The collared peccary has the ability to handle a large amount of roughage in its diet. Such a characteristic represents an attractive asset since the species could utilize byproducts of human food and farm production that have little current outlet. In order to improve the economic viability of collared peccary farming, this study concentrated on the reduction of costs through the establishment of diets based on locally available foodstuff resources. We identified 20 foodstuffs potentially useful for feeding collared peccaries, and their specific nutritional content and digestibility coefficients were determined by chemical and in vivo digestibility analysis, respectively. We determined the preference order and voluntary consumption of some of these foods. We used six pen-raised adult collared peccaries and six metabolism chambers. With the data on voluntary intake and digestibility, and the nutritional requirements found in the literature we established four experimental diets for collared peccary, two for reproductive animals and two for growing individuals.

Introduction

The collared peccary (*Tayassu tajacu*), a pig-like mammal, ranges throughout the American continent from New Mexico in the USA to northern Argentina, in habitats as diverse as semi-arid deserts and tropical rainforests (Sowls 1997). In Neotropical areas, the harvest of peccaries for meat and hides is widespread and overexploitation may become a threat to their natural populations (Bodmer et al. 1994). Therefore, it is necessary to test sustainable methods to exploit this species, preventing its depletion . Captive breeding is an option that has not been explored sufficiently, despite being repeatedly quoted in the literature (Sowls 1997). The experiences developed in Brazil are mainly conducted in large outdoor enclosures and some of them are yielding good results (Nogueira-Filho & Nogueira 2004).

In the Amazon region, the collared peccary is largely a frugivore, feeding mainly on the fruits of palms (Kiltie 1981, Bodmer 1989, Barreto *et al.* 1997, Fragoso 1999). Throughout its range a wide variety of roots, tubers, bulbs, and rhizomes contribute also to its normal diet (Sowls 1997). In captivity this animal adapts easily to different kinds of food such as cassava, cassava hulls, pumpkin, maize, sorghum silage, maize silage, sugar cane, and compound pig diets (Nogueira-Filho & Nogueira 2004).

Anatomically, this species has a fore-stomach with active fermentation (Langer 1979, Carl & Brown 1983, Cavalcante-Filho *et al.* 1998); this has given rise to considerable speculation regarding its ability to utilize roughage by transforming the dietary fiber to usable short chain fatty acids (Sowls 1997).

According to Sowls (1984) the pH of the fore-stomach of the collared peccary ranges from 5.7 to 6.1, and is a suitable environment for microbial bacteria capable of breaking down cellulose. Carl & Brown (1983) found live protozoa in the fore-stomach of collared peccaries. No studies have yet been done to reveal the importance of microbial protein synthesis for collared peccaries. Carl & Brown (1985) studied the protein requirements of this species, suggesting that the high digestibility for crude protein and the low protein requirements ~~supports~~ the evidence that the collared peccary has a digestive physiology more similar to that of ruminants than to that of non-ruminants.

Lochmiller *et al.* (1989) suggested that the short chain fatty acids found in the collared peccary fore-stomach arise from non-cellulose components of the diet. Shively *et al.* (1985) concluded that fiber digestion in the collared peccary is considerably lower than in true ruminants. Strey III & Brown (1989) suggested that collared peccaries might be concentrate selectors, selecting highly

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digestible plants and plant parts over those with higher fiber contents. However, the patterns of intake described by Theimer & Bateman (1992) indicated that the collared peccary does not forage selectively on the most nutritious pads of the prickly pear cactus. Other studies showed that the collared peccary could digest forage like true ruminants (Gallagher *et al*. 1984, Comizzoli *et al*. 1997). Considering these data, and grounded on work by Strey III & Brown (1989), Santos (2003) determined regression equations to compare in vivo digestibility by peccaries with in vitro digestibility of standards foodstuffs using cow rumen inoculum. These equations were used to estimate in vivo nutrient digestibility of foodstuffs used by collared peccaries (see Table 1).

Substantial technical progress is being achieved in collared peccary captive breeding (Nogueira-Filho & Nogueira 2004). However, only 5% of the 452 registered commercial breeding farms in Brazil breed this species. Indeed, many attempts to produce it have failed to date because of low economic return, the use of inadequate husbandry practices, including inadequate diets, and lack of knowledge of the social behavior of the species (Nogueira-Filho & Nogueira 2004*)*. Despite the ability of peccaries to digest low quality roughage, many collared peccary farms use commercial pig diets (which increase production costs (Nogueira-Filho 2005). In order to develop the economic viability of collared peccary farming, this study concentrated on the reduction of farming costs by the establishment of diets based on locally available foodstuff resources.

Methodology

Determination of voluntary intake and related foodstuffs preference order

In this study we used six pen-raised adult non-pregnant female collared peccaries. The animals were put in one of six individual metabolism crates constructed for metabolism trials at the Estação Experimental do Almada, the experimental farm of the Universidade Estadual de Santa Cruz, Ilhéus, Bahia, Brazil.

We selected 20 foodstuffs and each one of these ingredients was supplied together with a standard food (maize grain plus salt and mineral mix). A double choice test was carried out in order to establish the voluntary consumption and to determine the preference order. For each foodstuff the animals were placed in metabolism crates for a 10-day acclimatization period, and a 5-day data collection period. During both the acclimatization and collection period the standard food and the experimental foodstuff were available ad libitum. Water was available ad libitum, and the same caregiver provided the fresh food and cleaned the crates. Food samples were collected and frozen in plastic bags for later analysis. The entire experiment lasts 10 months.

Before analysis, feed samples were dried at 60^{o}C for 72 hour, and ground in a Wiley mill to pass through a 1-mm screen. The samples were analyzed and the contents of dry matter, ash, crude protein, ether extract, calcium and phosphorus were determined by classical laboratory procedures and cell wall constituents – neutral detergent fiber (NDF), acid detergent fiber (ADF) and lignin – were analyzed according van Soest *et al*. (1991). Gross energy of feed and feces were determined in a Parr adiabatic bomb calorimeter.

Developing of diets

According to Galagher *et al*. (1984) the daily requirement maintenance level of adult collared peccaries is 0,84-g of digestible nitrogen (DN) per kg of metabolic weight (MBW) and 148,5 kcal of digestible energy (DE)/kg of MBW. Galagher *et al.* (1984) suggested that the growing peccary needs to receive a diet with 162% more energy and nitrogen than the maintaining levels. They suggested also that the lactating female needs to receive a diet with 72% more energy and nitrogen than the maintaining levels. Based on this, we determined the nitrogen and energy requirements of growing peccaries with 10 kg of live weight and food intake of 5% of its live weight. In the same way, we established the requirements of lactating females with 22 kg of live weight and food intake of 3,5% of its live weight. The results are shown in Table 2. Since in Brazilian commercial peccary farms, all adult category animals remain in the same enclosures and it is impossible to furnish different kind of diets to pregnant, non-pregnant or lactating females, we call this diet a reproduction diet. On the other hand, in commercial peccary breeding the farmers use creep feeding to furnish the growth diet.

With regard to phosphorus requirements, Galagher *et al*. (1984) considered that the result obtained (0.844 g of phosphorus kg/kg MBW day) was greater than the real requirement, due to phytic acid and other secondary plant components that could precipitate phosphorus, calcium, and other minerals. Because of this there occurred a decrease in the mineral availability and the phosphorus requirement was overestimated in this study. In the present work we used the phosphorus and calcium pig maintenance requirements to formulate peccaries diets, and considered that the growing peccaries need to receive a diet with 162% more phosphorus and calcium than the maintenance levels requirements of a pig. On the other hand, the lactating peccary female needs to receive a diet with 72% more of both minerals (Table 2).

Through the levels of digestible protein (DP) and digestible energy (DE) of some foodstuffs predicted by regression equations obtained by Santos (2003) (Table 1) and peccaries nutritional requirements established by Galagher *et al.* (1984) (Table 2), we established four experimental diets, with conventional and non-conventional foodstuffs. The two diets for reproductive peccary females and the two diets for growing individuals were formulated through the SuperCrack Software (Version 3.0).

Results and discussion

The approximate chemical composition of the 20 experimental foodstuffs analyzed are presented in Table 3 and the preference order and the voluntary intake of each experimental foodstuff in Figure 1.

The average voluntary intake was 1.8 % of body mass on a dry matter basis. We also verified that there was no correlation between consumption preference and crude protein ($r_{Spearman}$ = -0,45; p = 0,09) or gross energy ($r_{Spearman}$ = 0,28; p = 0,3) content level in the different foodstuffs furnished in the present study. These data suggests that we need to chop and mix the ingredients of the peccary diets in order to obtain a regular intake of all components and avoid nutritional imbalance.

The collared peccary has digestibility coefficients of acid detergent fiber (ADF) and neutral detergent fiber (NDF) (Gallagher *et al*. 1984, Comizzoli *et al*. 1997) comparable to those found by van Soest (1982) in domestic or wild ruminants fed similar lignin contents. There is, however, a maximum tolerable level close to 300 g/kg of coarse roughage, equivalent to 281 g/kg of NDF, 142 g/kg of ADF and 56 g/kg of lignin, in the diet of peccaries (Nogueira-Filho 2005). This level is in agreement with the data obtained by Kiltie (1981) and Barreto et al. (1997) which established that roots, leaves and other vegetative parts of plants, high in fibrous contents, constitute around 300 g/kg of diets of peccaries in the Amazon region. This high digestibility for digestive fiber and the low protein requirements supports the evidence that the collared peccary has a digestive physiology more similar to that of ruminants than to that of non-ruminants (Carl & Brown 1983). Due to this similarity with ruminant physiology, the use of in vitro digestibility analyses, using cow rumen inoculum, is an effective method to estimate the nutrient digestibility coefficients for collared peccaries, as demonstrated by Strey III & Brown (1989). Furthermore, the ability of the collared peccary to utilize high levels of coarse roughage gives it a special place as an alternative species for animal production. This species could utilize the by-products of human food and coarse products of the farm which have found few other outlets to date, and it can be sustained on inexpensive locally available foodstuffs.

Using the data on voluntary food consumption levels obtained in the present study of 20 ingredients, the digestibility coefficients of several foodstuffs estimated by Santos (2003), the nutritional requirements for collared peccaries established by Galagher *et al.* (1984), and fiber level tolerance determined by Nogueira-Filho (*in press*), we established four experimental diets for collared peccaries in captivity using conventional and non-conventional foodstuffs. Two diets are for reproductive animals and two for growing individuals (Tables 4 and 5). These two different diets were formulated taking into account the seasonal availability of foodstuffs.

Other diets could be formulated with these data in other places with locally available foodstuffs. Additionally, these diets need to be evaluated with respect to animal production, recording data on food consumption, growth rate, and alimentary conversion rate. This will allow us to calculate the financial inputs and outputs of captive breeding of collared peccary and to evaluate its economic viability.

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Table 1: Estimate of in-vivo digestibility coefficients of dry matter (DMD), organic matter (OMD) and levels of digestible protein (DP) and digestible energy (DE) predicted by regression equations. Source: Santos (2003).

Foodstuffs	DMD (%)	OMD (%)	DP (%)	DE (kcal/g)
Cassava by-product meal	88,52	82,83	1,58	8.08
Opuntia	68,12	65,28	3,74	2,47
Banana	59,05	61,24	2,56	2,64
Passion fruit hulls	70,83	67,20	4,49	2,78
Andu leafs	3,55	16,70	13,34	0,89
Cocoa meal	20,95	29,24	12,03	0,99
Papaya tree	56,55	52,70	10,59	2,08
Jenipapo (Genipa americana)	81,00	74,41	3,16	3,36
Cassava hulls	30,04	45,97	6,18	1,58
Pineapple hulls	68,79	66,27	4,50	3,27
Banana tree	28,72	33,20	5,34	1,41
Soybean meal	93,22	83,31	38,52	3,95
Jack fruit	75,63	71,17	5,98	3,02

Table 2. Nutritional requirements of collared peccaries

Animal category	Digestible Protein (%)	Digestible Energy (kcal/g)	Phosphorus (%)	Calcium (%)
Lactating females	12,0	3,4	0,93	1,4
Growing individuals	15,4	2,7	0,87	1,3

Source: Galagher *et al*. (1984).

Table 3: Aproximate composition on a dry matter basis of 20 ingredients of conventional and non-conventional foodstuffs

Foodstuffs	Organic Matter (%)	Crude Protein (%)	Energy (kcal/g)	FDA (%)	FDN (%)	Ash (%)
Cassava	97,4	2,7	4,2	4,6	5,2	2,6
Cassava's leaf hay	87,6	28,2	4,6	53,8	61,3	12,4
Cassava hulls	81,9	8,7	3,8	4,0	9,0	18,1
Cassava by-product meal	98,3	2,7	9,7	12,0	20,0	1,7
Passion fruit hulls	91,6	6,5	4,1	11,3	40,5	8,4
Cocoa meal	90,0	16,9	3,4	12,0	43,1	10,0
Papaya tree	85,1	14,5	4,0	34,6	62,4	14,9
Banana	95,0	4,0	4,1	-	11,6	5,0
Banana tree	91,2	7,6	4,3	28,9	34,7	8,7
Pineapple hulls	95,2	6,5	3,4	11,0	38,0	4,7
Jenipapo (*Genipa americana*) fruit	96,2	4,7	4,5	-	13,0	3,8
Jack fruit	96,2	8,4	4,2	-	12,7	7,0
Pumpkin	89,3	20,0	4,9	31,1	28,6	10,2
Corn	95,6	10,9	4,8	6,3	23,3	4,4
Elephant grass	90,2	9,1	-	39,0	73,5	9,8
Palm oil meal	96,3	15,6	5,1	42,1	64,6	3,7
Soybean meal	93,0	51,0	4,2	5,4	8,2	4,7
Wheat meal	94,5	16,9	4,4	12,1	41,1	5,5
Fish meal	79,1	66,6	4,2	-	-	20,8
Blood meal	96,7	78,4	5,1	-	-	3,3

Table 4: Percentile composition of the reproduction diets

Ingredient	Reproduction Diet 1		Reproduction Diet 2	
	%	Rate/kg (USA$)	%	Rate/kg (USA$)
Cottonseed meal	16	0,08		
Wheat meal	5	0,06		
Bicalcium phosphate	0,3	0,17	4,5	0,17
Cassava root	33	0,02	25,0	0,02
Cassava's leaf hay				
Corn	14,2	0,10		
Cassava hulls	7	0,02		
Soybean meal	10	0,08	27,2	0,27
Pineapple hulls			35,0	0,005
Cocoa meal				
Jack fruit				
Pumpkin				
Calcium carbonate			0,6	0,06
Palm oil meal	10	0,05	7,3	0,05
Mineral and Vitamin supplement	0,1	0,25	0,1	0,25
Salt	0,5	0,03	0,3	0,03
Vegetable oil	2	0,05		
Total	100	0,06	100	0,09

Table 5: Percentile composition of the growth diets

Ingredient	Growth Diet 1		Growth Diet 2	
	%	Rate/kg (USA$)	%	Rate/kg (USA$)
Cottonseed meal				
Wheat meal				
Bicalcium phosphate	4,5	0,17	4,6	0,17
Cassava root	30,0	0,02		
Cassava's leaf hay	8,7	0,01	15	0,01
Corn				
Cassava hulls				
Soybean meal	32,6	0,27	26,4	0,27
Pineapple hulls				
Cocoa meal	5,0	0,02		
Jack fruit			21,6	0,01
Pumpkin	18,5	0,03	26,6	0,03
Calcium carbonate	0,4	0,06	0,4	0,06
Palm oil meal				
Mineral and Vitamin supplement	0,1	0,6	0,1	0,6
Salt	0,3	0,03	0,3	0,3
Vegetable oil				
Total	100	0,11	100	0,09