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Intake and Digestibility of River Buffalo Steers (*Bubalus bubalis*) Fed Different Levels of Palm Kernel Cake: Effect of Diet Neutral Detergent Fiber, Digestible Energy, Crude Protein and Extract Ether

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ABSTRACT

Take of Dry Matter (DM), Neutral Detergent Fiber (NDF), Digestible Energy(DE), Crude Protein (CP) and Extract Ether (EE) and total diet digestibility of DM, NDF, Crude Energy (CE) and EE were studied in crossbred river steers buffalo (*Bubalus bubalis*) receiving Palm Kernel Cake (PKC) and grass silage (*Pennisetum purpureum*). The experimental test was conducted in a completely randomized design with four treatments (levels of PKC) and four repetitions (buffalo). Each period lasted 21 days, being 14 days to adjust the level of inclusion and seven days to determine consumption and digestibility. Enriched and purified lignin, LIPEÒ, was used as an external indicator in order to estimate the apparent digestibility of the nutrients. The experimental diet consisted of PKC in levels of 0, 20, 40 and 60% added to 100, 80, 60 or 40% of silage, the repetitions were composed of four male crossbred buffalos with initial live weight of 380.10 ± 27.21 Kg. Data was analyzed by regression using statistic software PASW. Intake ($g/^{kg0.75}$) and digestibility (%) of (DM, NDF and CP), decreased from 0 to 40% and increased from 40 to 60% of PKC. Buffalo appeared to have a later adaptation to PKC.

Key words: Palm Kernel Cake, Buffalo, Intake, Digestibility, LIPEÒ, External Marker.

INTRODUCTION

Dry matter intake (DMI) is essential to define the amount of nutrients available to an animal and is responsible for animal´s response and function[1]. Animals seem to feed themselves regulating their intake in a way to avoid a discomfort[2]. A lot of factors that affect DMI have been reported and can be applied in a specific condition, and the regulatory mechanism of intake is influenced by a lot of these factors simultaneously[3]. Basically intake is affected by physical factors[4], metabolic factors[5], hormones factors, pathologies, environmental factors, rumen manipulation and interactions between cited factors. The basic and original model in animal nutrition states interaction of intake, passage and digestibility[6]. These principles have been expanded [7-9], but the underlying hypothesis is still the one proposed originally[6]. Neutral Detergent Fiber (NDF) is highly correlated with DMI, whereas it is said to be the best feed component to predict DMI[10]. DMI increases until it is not limited by rumen fill and decreases when limited by excess of metabolic products, which demonstrates the effect of rumen fill and chemostatisc over intake[11]. The digestibility of a feed is basically its capacity to allow an animal to use in a larger or straighter scale its nutrients. A difference between nutrient digestibilities in buffaloes and cattle, particularly of Crude Protein (CP), NDF and Acid Detergent Fiber (ADF) were reported[12].

External markers are largely used to predict animal fecal production and thus voluntary intake and digestibility. Most markers have many inconvenients like: incomplete homogeneity with ruminal digesta, low fecal recuperation, difficult chemical analysis[13] besides that the most common used, chromium oxide (Cr_2O_3) is also carcinogenic[1,14]. LIPEÒ, a purified and chemically modified hidroxifenilpropane made from natural lignin is being used as a marker, developed at Veterinary College of Federal University of Minas Gerais, Brasil. Recent studies have compared LIPEÒ with total fecal collect and Cr_2O_3 and showed to be superior than Cr_2O_3.[15-16]. A previous work was done in Cuba in order to verify LIPE´s use in buffaloes.[17]

Palm Kernel Cake is a biofuel byproduct largely found in Pará State, Brazil. Although some research was done to better understand it, its basic question hasn´t been answered which is its best level of addition into animal diet and energy content.

The current study aimed to evaluate the total intake ($g/Kg^{0.75}$) of DM, NDF, EE, CP and Digestible Energy (DE as $Kcal/Kg^{0.75}$) and apparent digestibility (%) of (DM, CE, EE, CP) and real digestibility of (NDF) in crossbred river steers buffalos receiving increasing levels of Palm Kernel Cake (PKC).

MATERIAL AND METHODS

The studies were conducted at Embrapa Eastern Amazon in the city of Belém, Pará, Brazil, whereas geographical coordinates are 1°25' south latitude and 48°26' west longitude of Greenwich. Four crossbred river steers buffalos with initial live weight of 380.10 ± 27.21 Kg were kept under individual feed and water systems and were fed twice a day (40% in the morning and 60% at the end of afternoon in order to respect animals' night feeding behavior) to evaluate intake of DM, NDF, TDN, EE, CP and DE and digestibility of DM, NDF, CE, EE and CP. The experimental diet consisted of Palm Kernel Cake (PKC) in levels of 0, 20, 40 and 60% added to 100, 80, 60 or 40% of grass silage (*Pennisetum purpureum* Schum) made with 120 d age grass with 5% of corn meal (Table 1). The experimental test was conducted in a completely randomized design, with four treatments (levels of PKC) and five repetitions (male buffalos) and were analyzed by regression using the statistic software PASW, an earlier version of PSPP. Each period lasted 21 d, 14 d to adjust the level of inclusion and 7d to determine consumption and digestibility. Enriched and purified lignin, LIPEÒ, was used as an external indicator in order to estimate the apparent digestibility of the nutrients. During six days of each treatment (15° to 20° day), once a day (8:00 am) one capsule of LIPEÒ, with 0.5 g of purified lignin was orally introduced through a esophageal probe to each animal. Fecal samples were collected for six days (16° to 21° day), once daily, from the rectum and packed in identified plastic bags and kept under -10°C. At the end of each week a composite sample was done and kept under same temperature. For LIPEÒ determination an IR-LAB Infrared Spectrophotometer with Fourrier Transform, by Büller was used. All laboratorial analysis were made in the Animal Nutrition Laboratory of Veterinary School of UFMG.

Table 1:

Chemical composition of the experimental diets and components (%DM).

Parameters	TOTAL DIET AS LEVEL OF PKC (%)				PKC mean composition
	0	20	40	60	
DM (%)	24,82	37,81	50,81	63,80	89,78
CP (%)	8,88	10,43	11,97	13,52	16,62
NDF (%)	76,55	76,59	76,63	76,68	76,76
ADF (%)	46,83	44,43	42,03	39,63	34,83
Lignin (%)	7,00	8,79	10,59	12,38	15,97
EE (%)	3,37	4,34	5,31	6,29	8,23
Ash (%)	4,09	3,97	3,85	3,73	3,49
EB (Mcal/Kg)	4,20	4,34	4,48	4,62	4,90

Daily feed weighing and sampling were done and further analyzed for DM, NDF, ADF, CP, CE and EE. DM, CP and EE were analyzed as AOAC[18]; NDF and ADF as Van Soest[1] and CE by adiabatic calorimetric bomb PARR. Daily adjustments were done in order to allow 10% of waste over total offered feed.

RESULTS AND DISCUSSION

Intake of DM, NDF, EE, CP, TDN are shown in table 2, regression equations and their related R^2 are shown in table 3.

Table 2: Dry matter (DM), Neutral Detergent Fiber (NDF), Extract Ether (EE), Crude Protein (CP), Total Digestible Nutrients (NDT) and Digestible Energy (DE) Intake of buffaloes fed different levels of Palm Kernel Cake (PKC).

LEVELS OF PKC (%)	INTAKE (g/kg$^{0.75}$/day)				INTAKE (Kcal/kg$^{0.75}$/day)
	DM	NDF	EE	CP	DE Intake
0	76.50	57.79	2.98	6.17	173.39
20	55.51	42.20	2.58	5.78	110.10
40	50.12	38.56	2.61	6.73	108.18
60	64.48	50.06	3.52	8.53	180.15

Table 3: Regression Equation of Dry matter (DM), Neutral Detergent Fiber (NDF), Extract Ether (EE), Crude Protein (CP), and Digestible Energy (DE) intake of buffaloes fed different levels of Palm Kernel Cake (PKC) and their respective coefficients of determination (R2).

Nutrient	INTAKE Regression Equation *	R^2
DM	$Y= 0.0221x^2-1.5329x+76.707$	0.9978
NDF	$Y= 0.0169x^2-1.15x+57.948$	0.9976
DE	$Y= 0.0845x^2-4.9804x+174.02$	0.9983
EE	$Y=0.0008x^2-0.0413x+3.0059$	0.9826
CP	$Y=0.0014x^2-0.0419+6.1421$	0.9974

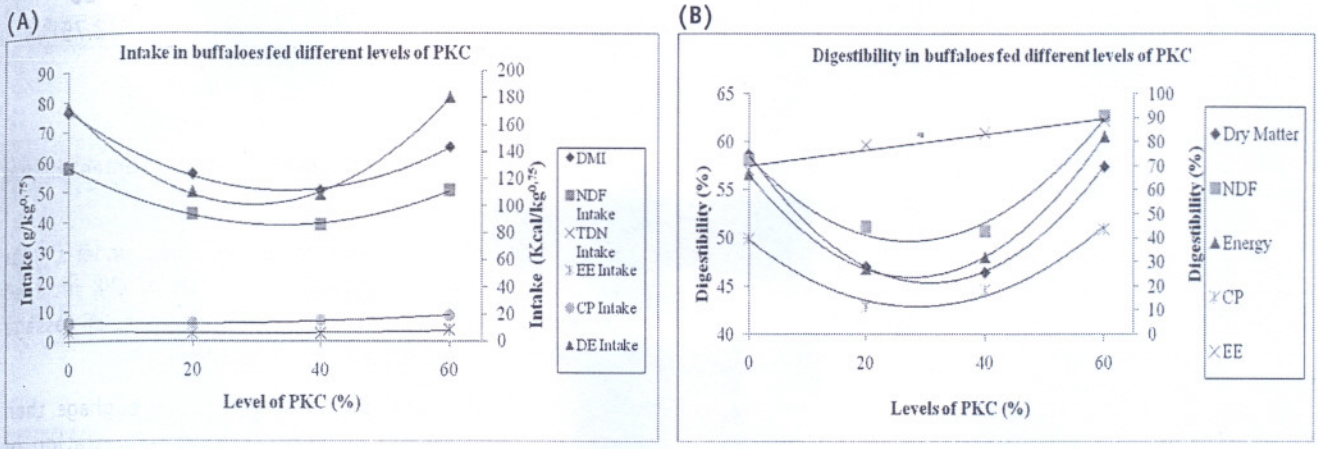
*x: level of PKC in the diet

Intake of NDF varied from 38.56 to 57.79 and seems to be the most limiting factor affecting intake in this assay. Crude Protein Intake ranged from 5.78 to 8.53 being 60% of PKC the highest level of intake, this previous result is higher than that found previously in Brazil when buffaloes with 400 KgBW had CP intake of 8.63 g/kg0.75, receiving a diet with 44.41% of concentrate.

Intake of NDF and DE decreased along with increasing levels of PKC up to 40%, from that on they increased until 60% of PKC; DE intake was the highest at this level. This may be due to the higher level of Extract Ether of PKC. In this treatment NDF intake was lower than that of silage alone. DMI varied from 50.12 to 76.50 g/kg$^{0.75}$ and these intake are similar to those related by previous researches: 62.4 g/kg$^{0.75}$ in buffaloes heifers, ranging from 290 to 340 Kg BW, receiving a diet based on grass hay[19]; and 62.61g/kg0.75 in buffaloes with 400 Kg BW fed different levels of concentrate.[20] And are lower than those found for male buffaloes with 380 KgLW receiving diets with lower (109.79 g/kg$^{0.75}$) and high (164.57 g/kg$^{0.75}$) levels of energy [21].

Intake of (DM, NDF, EE and DE) decreased between levels 0 and 40% of PKC and increased there for (graphic 1A). Diets chemical compositions do not explain this quadratic effect, what suggests that there was a late adaptation of the animals to the PKC. Factors able to explain this late adaptation need to be further studied and see if they are or not specific of the current specie. At 60% of PKC, buffaloes had the highest intake.

Graphic 1: Intake (A) and Digestibility (B) in buffaloes fed different levels of Palm Kernel Cake (PKC)



Digestibility (table 4 and 5, graphic 1B) of DM, NDF, CE (%) decreased between 0 to 40% of PKC and recovered after that. CE digestibility (%) increased linearly as expected and CP digestibility (%) increased at 40% of PKC. At 60% of Palm Kernel Cake buffaloes had the best percentage of digestibility of all nutrients.

Table 4: Digestibility (%) of Dry Matter (DM), Nitrogen detergent Fiber (NDF), Crude Energy (CE), Extract Ether (EE) and Crude Protein (C) of buffaloes fed different levels of PKC.

LEVELS OF PKC (%)	DIGESTIBILITY (%)				
	DM	NDF	CE	EE	CP
0	58.70	58.14	56.64	68.43	49.96
20	47.04	51.21	46.81	78.85	42.94
40	46.44	50.68	47.96	83.79	44.59
60	57.45	62.75	60.60	88.72	50.99

Table 5: Regression Equation of Dry matter (DM), Neutral Detergent Fiber (NDF), Extract Ether (EE), Crude Protein (CP), and Crude Energy (DE) digestibility of buffaloes fed different levels of Palm Kernel Cake (PKC) in Pará State, Brazil, and their respective coefficients of determination (R2).

Nutrient	Digestibility	
	Regression Equation	R^2
DM	$Y= 0.0142x^2-0.872x+58.728$	0.9999
NDF	$Y= 0.0119x^2-0.6463x+58.453$	0.9810
CE	$Y= 0.014x^2-0.7772x+56.662$	0.9999
EE	$Y=0.3291x^2+70.074$	0.9598
CP	$Y=0.0084x^2-0.4795+49.767$	0.9838

Table 6: Digestible Energy (DE) content of the treatments.

	LEVEL OF PKC(%)			
	0	20	40	60
DE (Mcal/kg)	2.27	1.96	2.08	2.75

Table six shows the DE of all treatments. From these data, it may be estimated that the digestible energy content of the PKC when used at 60% level is close to 3.00 Mcal/KgDM.

From the current study it can be concluded that best level of use of Palm Kernel Cake is 60% for buffaloes, under similar conditions. The quadratic effect of both intake and digestibility of the nutrients studied as the levels of CPK increase suggests that buffalos had a slow adaptation. Studies of rumen dynamics, in situ rates of degradation and rate of passage done in the same experiment, still under laboratory analysis, may help to better explain these results.

Considering the chemical composition, intake and digestibility, it seems that PKC is more closely to be a roughage than a concentrate feed. This may be of huge interest in Amazon Region because it can help decrease deforestation of Rainforest.

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