

Apparent digestibility of nutrients and physical-chemical characteristics from colon contents of horses

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Introduction

In horses, about 70 to 95% of plant cellular content digestion occurs at small intestine while cellular wall digestion occurs at hindgut (Martin-Rosset and Dulphy 1987). The fermentation conditions at caecal-colon of horse are similar to rumen with substrate supply, pH control, osmolality, anaerobioses, digesta retention and continuous removal of fermentation residues (Wolter et al. 1982). The large intestine in horses can be divided in four sections by a functional view: caecal, ventral colon, dorsal colon and smaller colon. In this way, it's possible to establish a pattern of continuous fermentation at four places. Anatomical characteristics and motility patterns of caecal and colon are responsible for selective retention of particles allowing microbial digestion (Hume and Sakaguchi 1991). This work aimed to evaluate apparent digestibility of nutrients and physical-chemical characteristics of colon contents of horses fed different diets with roughage and concentrate.

Material and Methods

The experiment was carried out at Equine Health Laboratory of Universidade Federal Rural do Rio de Janeiro with four horses with cannula fitted at right ventral colon. Surgical procedures were adapted to technique described by Lopes (2002). Four diets were supplied: Diet I - Tifton-85 hay (Cynodon dactylon); Diet II - Tifton-85 hay (50%) and alfalfa hay (Medicago sativa) (50%); Diet III - Tifton-85 hay (30%), alfalfa hay (30%) and concentrate I (40%); Diet IV - Tifton-85 hay (60%) and concentrate II (40%) (Table 1). The experimental design was 4x4 Latin Square, with diets supplied at six hours intervals during 21 days. Each experimental period had duration of 21 days, 14 days of diets adaptation, 5 days to faeces collection and 1 day to colon digesta collection. Apparent digestibility coefficients of nutrients were estimated through total collection faeces with appropriate bags for horses. At 21st day, colon contents were collected, about 700gr, at three times, 7:00, 9:30 and 12:00 hours, with plastic bags, in replicated. One sample was filtered in gauze filter with four layers and pH values were obtained with a pHmeter (Tecnopon, P.A 2000) immediately after filtration. Buffer capacity (BC) was estimated by titration of filtered digesta. Samples were diluted with distilled water (1:1 vol/vol) and

Table 1 Percentual and chemical composition of diets.

Items	Diets			
	Diet I	Diet II	Diet III	Diet IV
Alfafa hay	—	50.0	30.0	—
Tifton-85 hay	100	50.0	30.0	60.0
Concentrate I	—	—	40.0	—
Concentrate II	—	—	—	40.0
Total	100	100	100	100
Dry Matter (DM, %)	83.9	84.3	84.9	84.4
Organic Matter (OM, %)	94.6	92.6	94.0	94.4
Gross Energy (GE, Mcal/kg)	4.5	4.5	4.3	4.2
Crude Protein (CP, %)	12.5	14.2	14.1	14.8
Ether Extract (EE, %)	3.4	3.1	3.3	3.5
Neutral detergent fiber (NDF, %)	72.3	59.3	40.3	47.7
Acid detergent fiber (ADF, %)	34.0	33.2	21.4	22.3
Hemicelluloses (HEM, %)	38.3	26.1	18.9	25.5

added acetic acid 0,25 M under stirring from current pH to the pH 6 (BC2) and to pH 5 (BC1) (Zeyner et al. 2004). Others samples of colon digesta were composed by times, at natural matter basis, for each animal. Samples were stored at -20°C and at end of trial dried in forced ventilation oven (55°C), during 72 hours and grounded until 1 mm. Chemical analysis procedures of diets and colon contents were described by Silva and Queiroz (2002).

Values were submitted to variance analysis and means compared by Student-Newman Keuls test at 5% probability. Values of physical-chemical characteristics of colon contents were analyzed as split-plot design with diets as parcels and collection time as sub-parcels and means compared by Student-Newman Keuls test at 5% of probability.

Results

Any differences were observed ($P>0.05$) to coefficients of digestibility of DM, OM, CP, GE, NDF and ADF (Table 2). In diets II and III, the EE (53.86 and 56.88%) and HEM digestibility coefficients were lower than diets I and IV digestibility coefficients of EE (81.63 and 75.24%), respectively ($P<0.05$).

Table 2 Digestibility coefficients of nutrients of diets.

Item (%)	Diets				
	I	II	III	IV	CV
DM	53.51 ^a	48.96 ^a	60.42 ^a	65.42 ^a	14.5
OM	48.97 ^a	50.04 ^a	62.65 ^a	67.67 ^a	18.2
CP	72.99 ^a	66.50 ^a	65.95 ^a	74.84 ^a	5.9
GE	54.16 ^a	50.42 ^a	60.39 ^a	67.05 ^a	12.0
EE	81.63 ^a	53.86 ^b	56.88 ^b	75.24 ^a	9.0
NDF	66.28 ^a	47.69 ^a	47.34 ^a	57.74 ^a	19.3
ADF	42.16 ^a	43.32 ^a	36.54 ^a	48.70 ^a	29.0
HEM	76.88 ^a	55.56 ^b	52.13 ^b	65.20 ^{ab}	12.1

Means with same letter in line don't differ by SNK ($P>0.05$).

According to NRC (1989), the energy maintenance requirements of digestible energy (DE) for adult horses, of 2.0 Mcal/kg DM were attended. DE contents of diets varied from 2.27, in Diet II to 2.72 Mcal/kg DM, in Diet IV.

Any differences were observed ($P>0.05$) for physical-chemical characteristics of colon digesta in function of time collection at postprandial period (Table 3). Horses fed tifton-85 hay presented colon digesta DM levels of 20.8%, lower than in

Table 3 Chemical composition of colon contents, in dry matter basis.

Nutrients	Colon contents				CV (%)
	Diet I	Diet II	Diet III	Diet IV	
DM (%)	20.8 ^b	26.2 ^{ab}	34.1 ^a	36.0 ^a	31.7
OM (%)	73.43 ^a	74.1 ^a	77.6 ^a	78.9 ^a	6.2
CP (%)	8.9 ^b	10.2 ^{ab}	13.5 ^a	12.6 ^a	28.7
NDF (%)	50.1 ^a	50.5 ^a	44.5 ^a	54.2 ^a	16.9
ADF (%)	28.2 ^a	30.8 ^a	26.3 ^a	28.2 ^a	12.6
EE (%)	1.2 ^c	1.7 ^b	2.9 ^a	2.1 ^{ab}	36.2
pH	7.2 ^a	7.1 ^a	7.1 ^a	7.1 ^a	4.1
Buffer Capacity 1 (BC1, mmol/L)	7.2 ^a	8.4 ^a	8.2 ^a	8.0 ^a	28.4
Buffer Capacity 2 (BC2, mmol/L)	18.4 ^a	22.4 ^a	21.7 ^a	19.6 ^a	22.6

Means with different letters at same line differ by SNK test ($P < 0.05$).

horses fed diet composed by tifton-85 hay and concentrate, 36.0% of DM ($P < 0.05$).

In relation to CP levels in the colon content, it was observed smaller values in horses fed diet composed by tifton-85 hay, of 8.9% ($P < 0.05$) compared with levels observed in horses fed diets composed by tifton-85 hay, alfalfa hay and concentrate or tifton-85 hay and concentrate, of 13.5 and 12.6%, respectively. Differences were not observed ($P > 0.05$) in fiber colon contents, NDF varied from 44.5 to 54.2% on diets with tifton-85 hay; alfalfa hay and concentrate; and tifton-85 hay and concentrate, and ADF varied from 26.3 to 30.8%, respectively. Values of pH, BC1 and BC2 of colon digesta were similar for all diets ($P > 0.05$). Average value of pH was of 7.12, BC1 values varied from 7.2 to 8.4 mmol/L, while BC2 values varied from 18.4 to 22.4 mmol/L, indicating that pH and buffer capacity of colon digesta of horses didn't change in function of diet composition.

DM and CP contents of colon digesta of horses fed with Tifton-85 hay, Tifton-85 hay plus alfalfa and concentrate ($P < 0.05$), but these results can't be related to digestibility coefficients of nutrients. Colon digesta presented lower EE content in diets I (1.2%) than in diets II (1.7%), III (2.9%) and IV (2.1%), in despite of EE similar contents of diets.

Discussion

Intake of hay by long term increases saliva production, reduces dry matter of digesta at stomach and it influences microbial fermentation at large intestine. However, high percentage of grains in horse diets reduces efficiency of fiber digestion of microbial ecosystem at hindgut (De Fombelle et al. 1999). Martin-Rosset and Dulphy (1987) fed horses ad libitum with mixed diets with grass hay and concentrate, using proportions of 0, 30, 60 and 90% of roughage and they didn't observe significant effect in intake nor in nutrients digestibility of diets. Pagan (1994), evaluating thirty different horse diets with seve-

ral types of roughage and combinations among them, observed coefficients of digestibility of 45.4% for NDF and of 39.9% for ADF.

Although in this work weren't observed effects of diets on pH and buffer capacity of colon digesta, Zeyner et al. (2004), comparing diets with hay fed before or after oats, observed that buffer capacity and pH in faeces of horses were affected by diets.

Conclusions

Diets composed by tifton-85 hay plus alfalfa hay or by tifton-85 hay, alfalfa hay and concentrate presented smaller hemi-celluloses and ether extract digestibility coefficients than diet composed only by tifton-85 hay. Buffer capacity and pH at colon were similar among horses fed different diets.

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