Scientific Paper

Indicators of cecal fermentation in diets of meal from *Morus alba* variety Yu 62▲

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Abstract

Objective: To characterize some indicators of cecal fermentation in diets of meal from *Morus alba* L. variety Yu 62.

Materials and Methods: The *in vitro* simulation of the digestive process in the cecal segment of the gastrointestinal tract was carried out. For such purpose, the ceca from nine fattening rabbits, of 2 kg live weight, of the hybrid breed (NZB x SGB), were used. A complete randomized design was used, in which the diets with inclusion of meal from *M. alba* variety Yu 62 (50 and 100 %) and *Medicago sativa* L. as control, were analyzed. Indicators of cecal fermentation (short chain fatty acids and pH) were determined and the data were analyzed in the INFOSTAT system.

Results: Significant differences ($p < 0,001$) were shown among the treatments, with marked increase of the concentration of total short-chain fatty acids, in the diets with inclusion of *M. alba* meal, when compared with the control *M. sativa*, which is due to a higher proportion of acetate and butyrate and lower proportion of propianate in the *M. alba* diets.

Conclusions: The mulberry forage meal constitutes an alternative feedstuff, which can substitute *M. sativa* in rabbit feeding and favor the cecal fermentation indicators.

Keywords: digestibility, meals, *Medicago sativa, Morus alba*

Introduction

Important efforts are made worldwide to develop the nutritional potential of the available feeding resources in each locality, among which special importance has been given to forage trees and shrubs. Among the tropical forage species, mulberry (*Morus alba* L.) stands out. This plant is considered to have special connotation due to its high biomass production and favorable bromatological composition, aspects which are highly useful for the elaboration of meal aimed at rabbit feeding (López *et al.,* 2014; Savón *et al.,* 2017).

In rabbit rearing, the digestive physiology of these animals is highly advantageous, because they have a digestive tract that is adapted to the consumption of diets rich in structural carbohydrates, in addition to the fact that in the cecum and proximal colon an important microbial activity occurs (Rebours *et al*., 2017).

The values of cecal fermentation (short-chain fatty acid, pH and ammonia), influenced by the diet nutrients (Knudsen*,* 2014), are indicators that express the activity of the cecal ecosystem of the rabbit, for which the use of the cecal content in *in vitro* techniques is very important.

The objective of this study was to characterize some indicators of cecal fermentation in diets of meal from *M. alba* variety Yu 62.

Materials and Methods

Location of the study. The research was conducted in the department of Biophysiological Sciences of the Institute of Animal Science of the Republic of Cuba (ICA), located on the km 47 ½ of the Central Road, in the San José de las Lajas municipality, Mayabeque province, Cuba.

Feeding. Mulberry forages, variety Yu 62, were used, from the experimental farm Guayabal, geographically located at 22º 53 North latitude and 82º 02 West longitude, at 92 masl. In the farm there was availability of one hectare, formed by three fields of the variety Yu-62, two years after establishment, on a Ferralitic Red soil (Hernández-Jiménez *et al*., 2015). The alfalfa (*Medicago sativa* L.) pellets were acquired at the National Center for the Production of Laboratory animals (CENPALAB).

Two diets were formulated and elaborated, with different substitution levels of *M. sativa* (50 and 100 %) by *M. alba* meal, variety Yu 62, and the control with alfalfa (table 1).

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Table 1. Experimental diets corresponding to the fattening period.

Feedstuff	Substitution of *M. sativa* by *M. alba* meal, %		
	0	50	100
M. sativa meal	45,0	22,5	0
M. alba meal	0	22,5	45,0
Triticum aestivum L. meal	10,0	20,0	20,0
Zea mays L. meal	21,0	10,0	8,0
Glycine max (L.) Merr. meal	17,0	18,0	20,0
Lysine	0,2	0,2	0,2
Methionine	0,2	0,2	0,2
NaCl (sodium chloride)	0,3	0,3	0,3
Sugar	3,0	3,0	3,0
Oil	1,0	1,0	1,0
Phosphate	0,9	0,9	0,9
Carbonate	0,1	0,1	0,1
Pre-mixture vitamins and minerals	1,4	1,4	1,4
Calculated analysis			
Crude protein, %	18,0	17,8	17,9
Metabolizable energy, MJ	10,8	10,7	10,7
Crude fiber, %	12,8	13,8	14,7
NDF, %	24,0	26,9	29,7
ADF, %	16,6	18,1	19,5
Cellulose, %	13,0	14,3	15,6
Hemicellulose, %	7,4	8,7	10,2
Lignin, %	3,6	3,8	3,9

Animals, treatment and design. A complete randomized design was used, in which the samples of the diets with inclusion of mulberry meal, variety Yu 62 (50 and 100 %) and alfalfa as control, were analyzed in sextuplet.

The *in vitro* simulation of the digestive process in the cecal segment of the gastrointestinal tract was carried out. For such purpose, the ceca from nine fattening rabbits, of 2 kg live weight, of the hybrid breed (NZB x SGB), from CENPALAB, were used. The cecal inoculant was prepared according to the method described by Pascual *et al.* (2000). From the inoculant, 100 mL were added to each tube, after adjusting the pH to 6,9, and were incubated at 39 ºC in thermostated bath, during 48 hours. At the end of the incubation period, the pH was measured and 20 mL were taken from each sample of cecal content, which were deposited in a container with 0,02 mL of orthophosphoric acid, stored at -20 ºC until the analysis of the concentration of total short-chain fatty acids (SCFAt) and individual acids (acetic, propionic and butyric), determined by gas chromatography.

Statistical analysis. Variance analysis was carried out. The data were analyzed in the system INFOSTAT (Di Rienzo *et al*., 2012). The correlations were established and, in the necessary cases, the comparison between means was done by Fisher's LSD test (1935) for $p < 0,05$.

Results and Discussion

Table 2 shows the cecal fermentative activity, in which there were significant differences ($p < 0,001$) among the treatments, with marked increase of the SCFAt concentration in the diets with inclusion of mulberry meal when compared with the control (alfalfa). This was determined by the higher acetate and butyric, and lower propianate concentration in the diets with mulberry (Pinzon, 2014). Higher fibrolytic activity was also observed, due to the high hemicellulose content in such diets, which is of higher degradability in the cecum (Gidenne *et al.,* 2015).

Table 2. Cecal activity in diets with inclusion of *M. alba* meal (variety Yu 62).

Indicator	Control diet	50 % M. *alba*	100 % *M. alba*	SE ±	P - Value
pH	6,9[c]	6,5[b]	6,5[a]	0,01	
SCFAt, mmol/L	73,8[a]	91,1[b]	103,6[c]	0,75	
Acetic, mmol/L	34,7[a]	49,5[b]	59,8[c]	0,37	p < 0,0001
Propionic, mmol/L	18,3[a]	14,3[b]	10,5[c]	0,29	
Butyric, mmol/L	12,4[a]	17,8[b]	22,4[c]	0,35	
Other fatty acids, mmol/L	8,4[a]	9,5[b]	10,9[c]	0,34	

Different letters in the same row differ for p < 0,05

In the diets with mulberry, the highest digestibility of proteins and carbohydrates occurred at ileal level, because the proportion of digestible amino acids from mulberry and soybean is higher (Dihigo, 2007), as well as the inclusion of wheat, whose starch is more digestible in the small intestine (Cossu, 2014).

One of the peculiarities of mulberry is the absence of condensed tannins (Savón *et al.,* 2017), which precipitate proteins with interference in their digestibility (Legendre *et al.,* 2017). The above-explained factors influence the degradation of protein and starch at cecal level being lower, which allows the adequate production of short-chain fatty acids with pH stability (Lardot, 2018).

Conclusions

It is concluded that the meal from *M. alba* variety Yu 62 constitutes an alternative feedstuff, which can substitute *M. sativa* in rabbit feeding because it favors the cecal fermentation indicators.

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Authors' contribution

- George Enrique Vasallo-Jamet. Conceptualization, research, methodology, visualization, writing, revision and edition.
- Luis Enrique Dihigo-Cuttis. Conceptualization, formal analysis, funding acquisition, research, methodology, project administration, resources, supervision, validation, visualization, writing, revision and edition.
- Lourdes Lucila Savón-Valdés. Conceptualization, formal analysis, funding acquisition, research, methodology, project administration, resources, supervision, validation, visualization, writing, revision and edition.

Conflicts of interests

The authors declare that there are no conflicts of interests.

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