Aerobic Deterioration of Diets Containing Cassava Shoot and Root Silages

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Introduction

The use of cassava and its derivatives in the form of silage as a non-conventional animal feed is common practice among farmers in the world. The appropriate fermentation profile for cassava aerial part and root silages, with pH and lactic acid values within the recommended ranges (Mota et al., 2011; Garcez et al., 2022) and considerably high aerobic stability (Santos et al., 2020; Pitirini et al., 2021) have been observed.

However, when silage is mixed with other feeds and fed to animals, its stability is altered (Jobim et al. 2007). We believe that the common evaluation of silage aerobic stability in a temperature-controlled ambient provides treatment comparison but does not shot its actual behavior in the environment, nor possible interactions with the diet fed to the animal. It is therefore important to study the aerobic stability of diets containing silages. Therefore, the aim was to evaluate the aerobic stability of diets composed of cassava shoot and cassava root silages under field conditions.

Materials and methods

The experiment was conducted at the Farm School of the Federal Rural University of the Amazon – UFRA, located in the municipality of Igarapé-Açu, Pará, (01°07'21" S and 47°36'27" W). A completely randomized design was used, distributed in a 2×2 factorial, considering two sources of roughage (whole plant corn silage - WPCS; and cassava shoot silage - CSS) and two sources of energetic concentrate (ground corn - GC; and cassava root silage - CRS) in the composition of the diets, with four repetitions. The experimental diets were: WPCS+GC, WPCS+CRS, CSS+GC and CSS+CRS. The ingredients (roughage and concentrate) were manually mixed and the diets placed in plastic buckets (2 kg fresh matter) without compression. On days 0, 4 and 7 of the aerobic exposure period, the microbiological population was assessed using the Pour Plate technique, using specific culture media to identify Lactic Acid Bacteria (LAB), enterobacteria (Entero), yeasts and molds. The pH of the diets was measured on the same days. The temperature of diets and environment was recorded every 3 hours using digital thermometers, during seven days.Based on the temperature data, the following variables: aerobic stability (AS; days), time to reach maximum temperature (TMT, hours) and maximum temperature (MaxT, °C). Aerobic stability (AS) was the number of days it took for the silage to reach 5°C above ambient temperature.

Analysis of variance was carried out to test the effects of the roughage source (R), energeticconcentrate (C), day of aerobic exposure (AE; 0, 4 and 7), and their interactions, for microbial and ph data. The parameters AS, TMT and MaxT were evaluated considering the effects of R, C and the interaction R×C. All analysis were performed using the SAS statistical software (SAS, 2022). The means were compared using the Tukey test, considering $\alpha=0.05$.

Results

There was an interaction between R×C×AE ($P < 0.05$) for LAB and yeast counts and for pH Table 1). The LAB population did not differ among diets on days 0 and 7 of AE, but on day 4 it was higher in WPCS+CRS (6.70 log10 $cfu.g^{-1}$) and WPCS+GC (5.38 log10 $cfu.g^{-1}$) than the diets containing CSS, (Figure 1). Over the exposure period, there was a decrease ($P < 0.05$) in LAB from day 0 to day 4 in CSS+GC diet. For WPCS+GC and CSS+CRS, the LAB count did not differ over the AE period. For the enterobacteria population, there was no difference among diets, with counts below 1 log10 $cfu.g^{-1}$ on day 0. However, the count of this microorganism was higher throughout the aerobic exposure period ($P < 0.05$). Diets containing CSS or CRS shower lower counts of enterobacteria compared to WPCS diets ($P < 0.05$). For yeasts, there was a difference between the diets only on day 0, being higher in WPCS+GC (6.06 log10 $cfu.g^{-1}$), but it was not different from CSS+CRS (5.25 log10 $cfu.g^{-1}$) (Figure 1). Diets CSS+GC and WPCS+CRS had the lowest counts (4.74 and 4.29 log10 $cfu.g^{-1}$, respectively), but did not differ from CSS+CRS. The yeast population increased in all diets from day 4 onwards. As for pH on day 0, CSS+CRS (3.82) and WPCS+CRS (4.09), showed lower pH, but did not differ from CSS+GC (4.39). From day 4 onwards, all the diets had a pH above 7 (Figure 1).

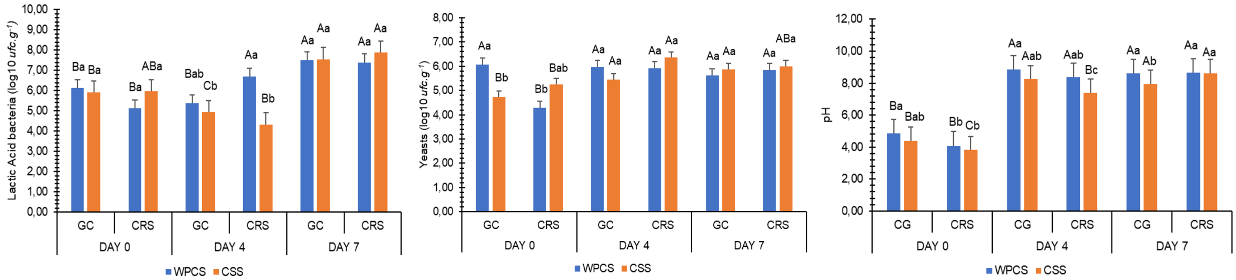
There was a R×C interaction for AS ($P < 0.01$), TTmax ($P < 0.01$) and Tmax ($P < 0.01$) (Table 1). WPCS+GC had the lowest AS (0.44 days; $P < 0.05$). CSS+GC and CSS+CRS did not differ ($P > 0.05$), with stability of 5.41 and 4.75 days, respectively, followed by WPCS+CRS, with stability of 3.38 days. These diets had higher ($P < 0.05$) TTmax and lower ($P < 0.05$) Tmax.

Table 1. Microbiology (log10 *cfu.g*$^{-1}$), pH, aerobic stability (AS), time to maximum temperature (TMT) and maximum temperature (MT) of diets composed of whole plant corn silage (WPCS), cassava shoot silage (CSS) and cassava root silage (CRS) throughout the aerobic exposure period.

Itens	WPCS		CSS		AE			SEM	R	C	R×C	R×C×DAE
	GC	CRS	GC	CRS	0	4	7		*P value*[1]			
LAB, log10 *cfu*$^{-1}$	6.33	6.41	6.13	6.06	5.78	5.34	7.58	0.26	0.24	0.97	0.75	0.03
Entero, log10 *cfu*$^{-1}$	4.47	3.54	4.76	4.36	0.22	5.26	7.24	0.79	<0.01	0.04	0.48	0.08
Yeast, log10 *cfu*$^{-1}$	5.87	5.48	5.35	5.87	5.16	5.93	5.83	0.10	0.94	0.91	<0.01	<0.01
Mold, log10 *cfu*$^{-1}$	7.29	6.27	5.72	5.49	5.31	6.22	6.91	0.23	<0.01	<0.01	<0.01	0.07
pH	7.43	7.04	6.86	6.65	4.28	8.28	8.46	0.52	<0.01	<0.01	0.21	0.04
AS, *days*	0.44	3.38	5.41	4.75	-	-	-	0.69	<0.01	<0.01	<0.01	-
TMT, *days*	3.13	5.63	6.88	6.72	-	-	-	0.55	<0.01	<0.01	<0.01	-
MT, °C	48.84	46.83	43.95	46.00	-	-	-	0.56	<0.01	0.96	<0.01	-

LAB: lactic acid bacteria; Entero: enterobacteria; DAE: day of aerobic exposure; SEM: standard error of the mean; R: effect of roughage; C: effect of concentrate; R×C: interaction between roughage and concentrate; (R×C)×DAE: interaction between roughage, concentrate and day of aerobic exposure. [1]α = 0.05.

Figure 1: Averages (log10 cfu.g-1) of lactic acid bacteria (LAB), yeasts and mold, and pH in diets composed of whole plant corn silage (WPCS), cassava shoot silage (CSS) and cassava root silage (CRS) throughout aerobic exposure.



GC: ground corn. Averages followed by different lowercase letters differ from each other during the same aerobic exposure period and averages followed by different uppercase letters differ from each other throughout the aerobic exposure period, according to the Tukey test (*P < 0.05*).

Conclusions

Diets containing CSS and CRS provided greater resistance to aerobic deterioration compared to diets containing of WPCS and GC, showing a longer shelf life under field conditions.

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