Chemical composition of whey with or without inclusion of a bacterial inoculant at different cooling times and its potential use as additive in pre-dried silages

C.D. Nath[1], M.A. Neres[1], C.R. Gregory[1], A. Giacomini[1], S.M. Hoppen[1], L.R. Da Silva[1] and L.C. Santos[1]
[1]*State University of West Paraná, Marechal Cândido Rondon, Paraná 85960-000, Brazil, Email: karolynedayane@hotmail.com*

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Introduction Tropical forage plants used for ensilage have unfavorable fermentative characteristics during their growth stages but high nutritional value, such as low levels of soluble carbohydrates (SCHOs) and dry matter, high moisture content, and high buffering capacity, which impairs fermentation and prevents pH reduction, making it difficult to obtain high-quality silages. Whey is a by-product of agro-industrial cheese production and contains lactic acid and SCHOs. Therefore, it presents a potential for use as an additive in silages, considering that the final objective of fermenting these roughages is the production of lactate. This can be applied in the ensilage production process to improve the fermentation pattern of silages when SCHOs and lactic acid, the products of lactic acid bacteria activity, are limited, thus reducing losses resulting from undesirable fermentation. Whey contains high amounts of water and some nutrients and therefore, must be refrigerated to prevent secondary fermentation. The objective of this study was to determine the chemical composition of whey with or without inclusion of a bacterial inoculant after different cooling times.

Materials and Methods The experiment was carried out at the State University of West Paraná - UNIOESTE, Campus of Marechal Cândido Rondon, Paraná. Fresh whey samples were collected at a whey powder production unit located in the municipality. These samples received bacterial inoculants (composition: *Lactobacillus curvatus*, *Lactobacillus plantarum*, *Lactobacillus acidophilus*, *Pediococcus acidilactici*, *Enterococcus faecium*, *Lactobacillus buchneri*, *Lactococcus lactis*, and *Propionibacterium acidipropionici* at concentrations of 1.0 × 10^{10} CFU g^{-1}) according to the manufacturer's recommendations; some samples were not inoculated as controls. The whey samples were collected immediately after production and were refrigerated in hermetically sealed glasses at 3°C to determine the bromatological composition. The evaluated periods were the time of collection (time 0) and 24, 48, and 72 h after application of the inoculant and after refrigeration. The dry matter (DM) content was determined as described by Silva & Queiroz (2006), soluble carbohydrates as described by Johnson *et al*. (1966), and protein and lactose contents by using the Milkoscope Expert® automatic analyzer. The data were analyzed in a completely randomized design and measurements were repeated at different time points. A mixed model was used with fixed effects of inoculant (1GL), cooling time (3GL), and their interactions (3GL); the random effects of the experimental error (18GL) were analyzed using the MIXED procedure of SAS® University Edition (SAS, Inc., Cary, NC, USA). Among all investigated error structures, the first-order AR (1) autoregressive structure showed the best results according to the Bayesian information criterion (BIC). In all analyses, results were considered significant when $P \leq 0.05$.

Results and Discussion SCHOs contents were not affected ($P > 0.05$) by the treatments and different cooling times (Table 1). The levels of CHOs recorded in whey samples inoculated or

not inoculated with commercial inoculant were below the levels (80–100 g kg^{-1}) for plants suggested by McDonald *et al*. (1991). Therefore, whey contributes with soluble sugars, which are necessary for improving the fermentative process of tropical forages, as these plants contain low levels of SCHOs. The low content of SCHOs impairs fermentation and prevents pH reduction, making it difficult to obtain high-quality silages. Protein and lactose levels differed ($P < 0.05$) after different refrigeration times of whey with or without the addition of commercial inoculant. Higher levels of protein in whey with or without inclusion of bacterial inoculant were observed in refrigerated samples after 48 and 24 h, respectively; however, these fresh samples are considered as non-protein substrates when added in silages. Higher lactose concentrations in whey with or without inoculant were detected in refrigerated samples after periods shorter than 48 h. Protein and lactose contents were not affected ($P > 0.05$) by the treatments. DM contents varied ($P < 0.05$) between cooling times, with lower contents at 48 h, at which time the highest DM concentration was observed in the whey containing inoculant.

Table 1 Chemical composition (g kg^{-1}) of whey with or without inclusion of bacterial inoculant at different cooling times

	Soluble Carbohydrates				Dry Matter			
	0 h	24 h	48 h	72 h	0 h	24 h	48 h	72 h
W/o Inoculant	62.6Aa	68.2Aa	56.3Aa	68.8Aa	55.77Aa	57.90Aa	53.85ABb	56.60Aa
W/ Inoculant	64.1Aa	6.02Aa	54.4Aa	70.1Aa	56.32Ba	59.95Aa	56.27Ba	58.55ABa
SEM								
Inoculant			0.360				0.036	
Cooling Time			0.484				0.054	
Inoculant* Cooling Time			0.684				0.076	
	Protein				Lactose			
	0 h	24 h	48 h	72 h	0 h	24 h	48 h	72 h
W/o Inoculant	22.15Aa	22.07ABa	21.18Ba	21.18Ba	33.10Aa	33.02Aa	32.67Ba	32.70ABa
W/ Inoculant	22.37Aa	22.35Aa	21.97Ba	22.15ABa	33.50Aa	33.42Aa	32.90Ba	33.12ABa
SEM								
Inoculant			0.010				0.015	
Cooling Time			0.009				0.012	
Inoculant* Cooling Time			0.012				0.018	

Means followed by the same letter, lowercase in the columns and uppercase in the row, do not differ by Tukey's test ($P < 0.05$). W/o inoculant: without inoculant, W/ inoculant: with inoculant. SEM: Standard error of the mean.

Conclusions As an additive, whey showed low potential for improving the chemical composition of silages. Whey contains high levels of lactose and protein when stored for less than 24 h. The inclusion of inoculant in whey increases the dry matter content when stored for less than 48 h under refrigeration.

References

Johnson, R. R., T. L. Balwani, L. J. Johnson, K. E. McClure, and B. A. Dehority. 1966. Corn plant maturity: II Effect on in vitro cellulose digestibility and soluble carbohydrate content. J. Anim. Sci. 25:617-623.

McDonald, P., A. R. Henderson, and S. J. E. Heron. 1991. The Biochemistry of Silage. 2nd ed. Chalcombe Publications, Marlow, Buckinghamshire, UK.

Silva, D. J. and A. C. Queiroz. 2006. Análise de alimentos: métodos químicos e biológicos. 3rd ed. UFV, Viçosa, Minas Gerais, BR.

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