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Silage of by-products of artichoke. Evolution and modification of the quality of fermentation

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SUMMARY - Silage of artichoke inflorescence by-products is tested in micro-silage with or without addition of formic acid at 4%, dehydrated sugarbeet pulp or salt. A fermentation kynetics occurs between day 2 and day 100 after silage. In all cases fermentation is very considerable and losses are high from day 50 onwards. The preservatives tried did not produce any effect. Due to the high water content of the by-product it is recommended to dehydrate it to possibly use it in animal feeding.

RESUME - "Evolution fermentaire de l'ensilage des sous-produits de l'artichaut". L'ensilage des sous-produits des inflorescences de l'artichaut est expérimenté en micro-silo sans additif ou avec de l'acide formique à 4%, des pulpes de betteraves déshydratées ou du sel. Une cinétique des fermentations est effectuée entre 2 et 100 jours d'ensilage. Dans tous les cas, les fermentations sont très importantes et les pertes sont élévées à partir de 50 jours. Les conservateurs expérimentés sont sans effet. De fait de la forte teneur en eau du sous-produit, il est recommandé de le déshydrater pour pouvoir l'utiliser dans l'alimentation animale.

Introduction

The by-product from the canning of artichoke is used as animal feed in the Murcia region, S.E. Spain (Martínez and Medina, 1982). However, the production of large quantities in a short period of time represents a considerable inconvenience as it cannot all be consumed by livestock before it begins to undergo a certain degradation. It is therefore necessary to consider some forms of conservation and in this paper we study one option, that of silage.

The determination of volatile fatty acids in silage is important not only because they are considered precursors of energy and fatty substance of some products (Villalón and Suárez, 1961) but also because they are indicative of the quality of fermentation of silage (Catchpoole and Henzell, 1971; McDonald and Whittembury, 1973; Pinheiro Machado, 1985). Both reasons, then justify the study of the fermentative quality of a silage through the evolution of these acids.

In a parallel study and along the lines of Castle and Watson (1985) and Fisher et al. (1985), etc, who studied ways of improving silage by means of additives, we study the effect of three such additives on the fermentative quality of an artichoke by-product.

Material and methods

The material used in the experiment, the result of the removal of the bracts and thallus from artichoke inflorescence, underwent silage in microsilos, from which samples were removed on days 2, 4, 7, 12, 24, 36, 48 and 100.

Silos to which had been added formic acid diluted to 4% (62.5 cc/kg), dehydrated beetroot pulp (62.5 cc/kg) and sodium chloride were compared to the control silos.

The following were determined: dry matter, pH, lactic, acetic, propionic, isobutyric and butyric acids, according to the methods used by Canale et al. (1984).

The curves reflecting the evolution of the different parameters were fitted by means of simple regression analysis, using variance analysis (Least Square Difference) to differentiate between lots.

Results and discussion

During the silage process, the artichoke by-product produces a steady increase in lactic acid concentration during the first 12 days (from 2.63% to 7.5%) on dry matter. Thereafter this diminishes until, at the end of the experiment, it reaches 1.5%, 2.63% less than the initial value. This phenomenon, which is in accordance with Beck (1978), can be explained by the lactic acid being used as energy source by the yeast during the first days of the experiment, the values obtained remain within the limits considered as optima for a good silage (3 to 13%), according to Cathpoole and Henzell (1971) (Table 1).

Similarly, there is an increase in acetic acid, although this is not so easily explained. For McDonald and Whittembury (1967) it might be the result of the clostridial fermentation of amino-acids. For Luis and Ramírez (1985) it may be related to the increase in metabolic activity on the past of the yeasts, which are present in similar quantities to lactic acid bacteria. Whatever the reason, there are changes in the majority presence of one or other acid producing an increase in the silage instability.

The concentration of butyric, propionic and isobutyric acids (Table 1) undergoes a similar evolution to that observed for acetic acid, showing clearly the pattern of volatile fatty acid evolution.

The concentration of the different organic acids produced by the lots treated with additives and the control lots are shown in Table 2, where it can be appreciated that the best fermentation was obtained with the control. The differences between the treatments were not significant, as revealed by variance analysis. These results are in agreement with those of Haigh (1957), who affirms that additives do not always produce better results in silages of high humidity.

On the other hand, pH (Table 1) showed a tendency to rise, although in the first 2 days it fell appreciably from 4.10 to 3.12%. However the pH remained within the limits advised by most authors. As regards differences in pH between the various treatments (Table 2), it is the formic acid which produces thelowest pH, as could be foreseen, although no significant differences appeared between the different treatments.

Dry matter underwent considerable fluctuations during the period under study (Table 1). The material used in the experiment have high initial humidity (82.11%), which makes their conservation a difficult process. For Hardy (1980) and Amella et al. (1982) the percentage of dry matter in vegetal crops destined for silage should be 25-30% which rises to 35-40% when tower silos are used.

Table 1. Mean concentration of fermentation parameters in silage of artichoke by-product (% dry matter).

Day of sample	Lactic acid	Acetic acid	Propionic acid	Isobutyric acid	Butyric acid	p^H	Dry matter
0	2,63	1,13	0,10	0,03	0,13	4,10	17,89
2	4,70	0,76	0,13	0,10	0,16	3,81	18,42
4	5,93	0,73	0,16	0	0,13	3,50	18,10
7	7,23	2,00	0,33	0	0,20	3,19	17,08
12	7,50	0,93	1,40	0	0,16	3,12	20,01
24	7,03	2,53	0,26	0	0,16	3,46	19,93
36	4,33	2,96	0,20	0,20	0,30	4,14	22,71
48	5,96	2,70	0,13	0,13	0,23	3,40	20,63
100	1,56	4,93	1,20	0,66	1,10	4,27	15,63

Table 2. Mean composition (% dry matter) and variance analysis (LSD) in various treatments of artichoke by-product silage.

Treatment	Lactic acid	Acetic acid	Propionic acid	Isobutyric acid	Butyric acid	p^H	Dry matter
(level of signif.)	(0,398)	(0,429)	(0,363)	(0,071)	(0,610)	(0,584)	(0,167)
Sodium chloride	2,53*	4,36*	1,06*	1,06*	1,30*	4,31*	17,75*
Beetroctpulp	1,93*	5,80*	1,06*	1,06*	1,43*	4,16*	18,92*
Control	2,80*	3,90*	0,80*	0,93*	0,90*	4,08*	16,02*
Formic acid	2,33*	4,43*	1,26*	0,60*	1,60*	4,08*	16,38*

Conclusions

The high water content of the original material used, result of the industrial processes to which it is submitted, limits, to a great extent, the quality of the silage and makes a previous treatment of drying or ventilation advisable. The evolution of the fermentations indicators - organic acids -shows that artichoke by-products produce an acetic fermentation. This explains the progressive degradation of the silage in the second half of the experiment. This implies that the silage should be used during the first 50 days if considerable losses in quality are to be avoided. The additives used in the doses reported, do not improve the fermentation quality of artichoke by-product.

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