SOME FACTORS AFFECTING SILAGE FERMENTATION[1])

I. *Influence of laceration and storage temperature*

G. W. WIERINGA

Institute for Storage and Processing of Agricultural Produce,
Wageningen, The Netherlands

Summary

Laboratory-scale ensiling experiments demonstrated that the laceration of grass stimulates bacterial development. The enhanced growth rate of the lactic acid bacteria results in a more rapid fall of the pH, and consequently in better preservation of the crushed grass.

It was possible to establish that this growth-promoting effect is caused by the liberation of sugars from the bruised grass cells. Emphasis is laid on the necessity of wilting or the use of additives when ensiling crops poor in sugars.

A low storage temperature proved to be equally important for the course of the fermentation of both lacerated and untreated grass silages. At a silage temperature of 30° C the effect of the crushing was nullified by the optimal development of the butyric acid bacteria.

Introductory

The laceration of grass is a very helpful method of obtaining a good silage quality (Kappelle and Leniger, 1958). Other investigations show less positive or even negative results (Balch et al., 1955; Cowan et al., 1957).

It is known from farm-scale experiments that crushed grass can be packed down very tightly. The exclusion of air probably prevents the silage from being heated, thus influencing the bacterial fermentation. Another possibility, already mentioned by Murdoch et al., is that crushing liberates sugars from the plant cells. In some laboratory-scale experiments an attempt was made to establish what effect the crushing of grass has on the development of lactic acid bacteria.

Methods

Silages were made in one- or two-litre preserving jars according to a method previously described (Wieringa, 1957). The experiments were carried out in August and September with grass from permanent pastures. The grass was chopped to 5 cm pieces with a hay chopper. The mincing was done with a meat-mincer. Grass was lacerated with the same apparatus without the cutting plate. Lactic acid bacteria counts were made according to Keddie (1951).

Results

In order to establish what effect the mincing of grass has on the development of the lactic acid bacteria, small silos were filled with chopped grass or minced grass and incubated at 20° and 35° C. The silages were opened after 1, 2, 4 and 8 days for pH determination and lactic acid bacteria counts and after 3, 8, 16, 30 and 60 days for chemical analysis. The grass contained 19.2% dry matter with 20.2% crude protein and 26.1% crude fibre in the dry matter. Fig. 1 shows that the lactic acid bacteria developed more rapidly in the minced grass silages than in the silages made from chopped grass.

The effect of the storage temperature was not so clear, a high temperature stimulating growth in the minced grass and retarding the development in the chopped grass silage. But it is assumed that mincing the grass results in a better availability of nutrients. This would explain why the initial growth

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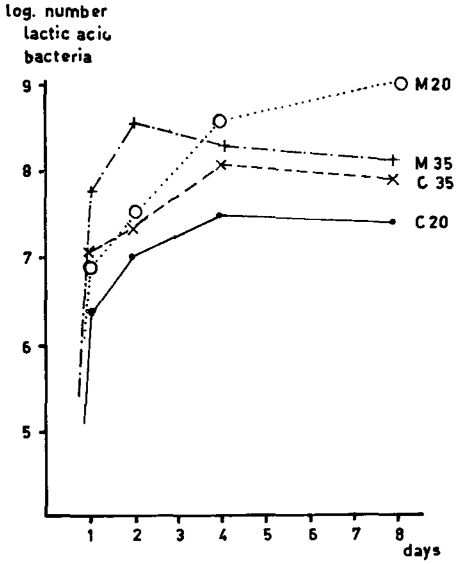

FIG. 1 GROWTH RATE OF LACTIC ACID BACTERIA IN SILAGE FROM MINCED (M) GRASS AND CHOPPED (C) GRASS, KEPT AT 20° C AND 35° C.

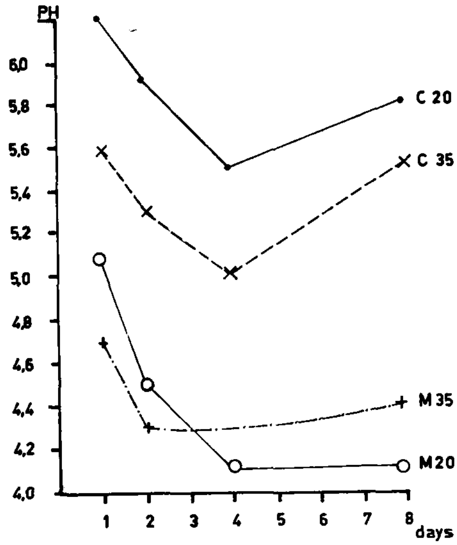

FIG. 2 pH DEVELOPMENT IN GRASS SILAGES MADE FROM MINCED (M) OR CHOPPED (C) GRASS, KEPT AT 20° C AND 35° C.

rate of the bacteria in silages from chopped grass was checked by the lack of available nutrients but not by an unfavourable temperature.

This agrees with the pH data (Fig. 2). A comparison of these data with Fig. 1 shows a correlation between the growth rate and the decrease in pH. In the silages from chopped grass the lactic acid bacteria were unable to produce enough lactic acid to give a sufficiently low pH in a short time. According to the data in Figs. 3 and 4, this slow decrease in pH led to the

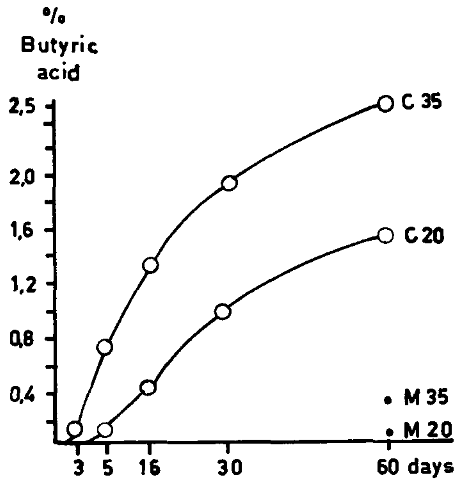

FIG. 3 RATE OF BUTYRIC ACID PRODUCTION IN SILAGES MADE FROM MINCED (M) OR CHOPPED (C) GRASS.

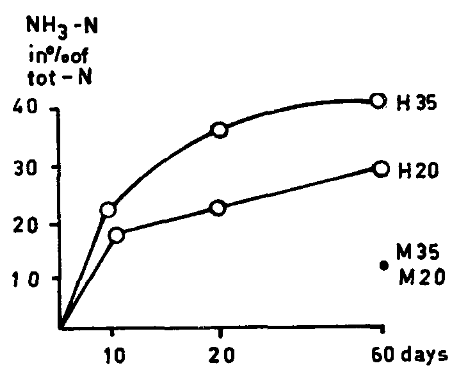

FIG. 4 INFLUENCE OF MINCING (M) AND CHOPPING (C) ON THE BREAKDOWN OF PROTEIN IN SILAGES, STORED AT 20° C AND 35° C.

production of large amounts of butyric acid and considerable losses of crude protein. The butyric acid figures show that the production of this acid may occur earlier and much more rapidly than is often supposed. Since no press-sap losses occurred in these laboratory silages the ammonia fraction figures (Fig. 4) give a reliable picture of the crude protein losses during fermentation.

It can be concluded from this experiments that the course of fermentation greatly depends on the initial growth rate of the lactic acid bacteria. Mincing the grass obviously liberates sugars from the grass cells, thus providing the lactic acid producing bacteria with a more directly available substrate.

In view of this result a second experiment was conducted in order to compare the effect of crushing on silage quality with the effect of adding molasses. Chopped grass with and without addition of molasses was stored in glass jars at 30° C. The lacerated grass silages were stored at 30° and 20° C. The latter temperature was chosen because farm-scale experiments had shown that silages made from chopped grass reach higher temperatures than lacerated grass silages (KAPPELLE, personal communication).

From the high protein content and the low dry-matter content of the grass it was expected that an inferior silage would be produced. After a storage of 4 months this was confirmed by the chemical analysis of the silages (Table 1).

Table 1 Chemical composition of silages, made from grass with molasses and from crushed grass.

Description	Storage tempera-ture °C	pH	In % of fresh				In % of dry matter		NH_3-N in % of total N
			butyric acid	acetic acid	lactic acid	dry matter	crude protein[1])	crude fibre	
Grass	–	–	–	–	–	14.1	21.9	20.0	–
Silage :									
Mown grass	30	5.1	2.1	0.5	0.2	10.0	21.0	26.4	37.0
Do + 1 % molasses	30	5.0	1.7	0.2	0.6	11.1	22.7	25.5	25.5
Do + 2 % molasses	30	4.8	1.3	0.2	0.8	11.6	22.2	23.8	20.5
Do + 3 % molasses	30	4.6	1.1	0.2	1.0	12.9	21.9	20.6	19.0
Do + 4 % molasses	30	4.0	0.3	0.4	2.2	14.8	21.2	18.8	13.0
Crushed grass	30	4.9	1.7	0.2	0.5	11.4	22.5	25.3	25.5
Crushed grass	20	4.1	0.3	0.5	1.9	12.4	21.9	20.4	14.0

1) Crude protein is free of ammonia.

An addition of 4% molasses appeared to be necessary for good preservation of the chopped grass. The crushed grass silages incubated at 30° C were of a poor quality, comparable with that of the 1% molasses silage. The quality of the cold stored crushed grass silage was very good and was comparable with the addition of 4% molasses.

It can be concluded from these results that the laceration of grass has the same effect on silage fermentation as the addition of sugars. But the butyric acid bacteria in the crushed grass stored at 30° C benefited by the better availability of the sugars. It should be emphasized that when ensiling lacerated grass it is just as important to maintain a low temperature for preservation as when ensiling untreated grass.

Fortunately in practice the crushed grass sets better than mown grass, thus preventing the inclusion of oxygen and consequently excessive heating of the silage.

It will be clear that laceration of a crop cannot improve the silage quality when it has a low sugar content or when the temperature in the silage approximates the optimum temperature of the butyric acid bacteria. In these cases wilting or the use of molasses or other additives will be necessary in order to preserve the crop.

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