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CONSOLIDATION AS A FACTOR IN SILAGE FERMENTATION

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OF RECENT YEARS, silage research has been largely concerned with the effects of various chemical additives on silage. The interest in additives may stem from the belief that it is impossible to obtain adequate control of the fermentation process without such aids. However, a search of the literature shows that no attempt has been made to correlate the course of the silage fermentation or the resultant end-products with the physio-chemical condition within the fermenting mass, or with the environment resulting from the complex effects of consolidation, aeration, and heating of the ensiled material. Certainly opinions on these matters have been published, and those of S. J. Watson (1939) have provided the basis of the ensilage technique practised in this country for many years.

Watson considers that the correct environment for lactic acid fermentation is encouraged by restricting, but not eliminating, air from the system. He considers that completely anaerobic conditions are undesirable since they are liable to encourage the wrong types of microorganisms. In practice, the restriction of air is achieved by controlling consolidation, and the effectiveness of controlled consolidation is evaluated by measuring the temperature.

It is doubtful whether many farmers regard silage temperatures in this light; rather heat development is considered essential so that the material may be rendered palatable. Watson can be quoted on this point: "The temperature of the herbage in the silo is of the greatest importance, and is thought by many to be the controlling factor in making silage. It is better to think of it as an indicator of the efficiency with which the first stage of the ensilage process is being controlled." As already noted this first stage involves the restriction of air by controlled consolidation.

Ruakura studies were commenced with the idea that chemical additives were essential, and most of the initial work was on the use of additives. The ordinary silages, made for comparison with chemically treated silages, attempted to apply Watson's ideas. It soon became apparent that there was still much to be learned about making ordinary silage before investigating the use of

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chemicals, and later work has been concentrated on measuring the effects of consolidation on the silage process. This paper presents the progress made in these investigations, the results of which conflict strongly with the current New Zealand philosophy of silage making.

By way of introduction to the silage problem, it was decided not to study any one particular aspect of the subject, but rather to make silages by a wide variety of methods and describe them with objective measurements. To this end a battery of small scale silos was erected at No. 5 Dairy. With 18 of these available, it was possible to put up nine treatments in duplicate.

A silo was filled in one day. At the completion of filling the grass was weighted with 500 lb concrete slabs, or it may have been left exposed to the air if the treatment required this. After a settling period of a week, the silos were topped up with similar material similarly treated, a disc of sacking marking the boundary between the first and second filling. The grass was sealed with a plastic sheet, weighted down and left until required. The second fill of grass was regarded merely as sealing material, and did not enter any measurements. The objective was to eliminate surface effects as far as possible, as the investigation was concerned with the products of fermentation only.

After a period of about 6 months, the silos were emptied, the silage weighed, sampled, fed to sheep for digestibility measurements and submitted to chemical analysis.

The silages were evaluated in terms of dry matter digestibility, dry matter loss, pH, lactic acid, ammonia nitrogen, total nitrogen ratio.

Over the last four years silages have been made with grasses at various stages of maturity, and submitted to different degrees of compaction. The heaviest compactions resulted in little or no temperature rise, whilst the lighter compactions gave temperatures of the order of 80 to 120°F. Silages made with heaviest consolidation were superior in all respects to the other silages. The heaviest consolidation of immature grass yielded the best fermentation characteristics.

In 1958 the fermentations in grass heavily and lightly consolidated were followed over a 21-day period. Temperature changes were negligible with the heavy compaction, and reached 105°F in the light compaction. Lactic acid concentrations increased at similar rates in both treatments for the first seven days, after which the concentrations in the "light" treatment remained constant, while that in the "heavy" treatment continued to increase to exceed 10 per cent. (dry basis) on the 21st day. Soluble sugar concentrations decreased rapidly in the light treatment and much more slowly in the heavy treatment.

In view of these data it is possible to arrive at only one conclusion as to the optimum condition for the silage fermentation, that is one of complete anaerobicity, achieved as rapidly as possible. The fact that there is such a large body of informed opinion which would oppose this conclusion cannot be ignored, and reconciliation between the two views should be sought. Perhaps the answer will be found in the water relationship in silage fermentations. The question of water has not been raised in this paper because the procedure adopted sought to eliminate the water factor by using herbage carrying little surface moisture, and by providing effective drainage. As far as can be made out, however, most undesirable fermentations, or most unpalatable silages are associated not only with over-consolidation and coldness, but also with wetness. The data presented would suggest that this situation would not be rectified by letting air in and encouraging heating. Rather does the solution lie in letting the water out, and the problem may be reduced to one of drainage.

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Literature Cited

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DISCUSSION

Q.: *The moisture content of herbage of different maturities varies enormously. How does Mr Lancaster explain his results in view of this?*

A.: The moisture content of the three herbages employed were very similar, despite the fact that they were cut at fortnightly intervals. I cannot explain why this should be.

Q.: *Would not laceration improve ease of consolidation?*

A.: Yes, but the relative effects of better consolidation and quicker release of juices by laceration have not yet been cleared up.

Q.: *How does the consolidation obtained in the field silos compare with that obtained in pits?*

A.: We have no comparative measurements, though I consider that in the heaviest consolidated field silos, the compaction would be greater than in the field.

Q.: *Have you any information on palatability of your test silages?*

A.: There was insufficient material to run palatability trials. Sheep reaction in digestibility work indicated that the heated silages were the least palatable. The cold silages were quite readily eaten.

Q.: *In view of the short period over which temperatures remained elevated compared with the much slower cooling of field silages, would this have modified the results obtained on the pilot scale?*

A.: To some extent, yes, though the initial happenings appear to be the important ones, and these are unlikely to have been modified very much by rapid cooling.

Q.: *Is heat* per se *important, is it a measure of some other activity, and could you insulate your silo?*

A.: Nobody appears to know whether heat *per se* plays any part in the silage fermentation, but certainly it is a measure of other activities. We do not intend to insulate the pilot silos, but are in the process of making equipment with which heat production can be measured.