

Dewar W A & McDonald P. Determination of dry matter in silage by distillation with toluene. *J. Sci. Food Agr.* 12:790-5, 1961.
[Edinburgh School of Agriculture, Scotland]

This paper reports on the volatile losses from silage during determination of dry matter by distillation with toluene. By correcting for these losses an estimate of dry matter may be made that is more accurate than that from oven-drying. [The SCI® indicates that this paper has been cited in over 140 publications since 1961, making it one of the most cited ever published in this journal.]

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"An accurate knowledge of the dry matter content is very important in silage studies. It is needed in order to measure fermentation losses and to assess the nutritional value of the silage. With fresh herbage the dry matter can be determined satisfactorily by oven-drying, but, after herbage has been ensiled, dry matter cannot be estimated accurately in this way; this is because some of the products of fermentation are volatile during oven-drying. These substances include the lower fatty acids, some lactic acid, ethanol, and ammonia.

"When I joined the University of Edinburgh as a research student in 1956, it was a centre of considerable activity in silage research. Two teams of workers were led by Sir Stephen Watson of the School of Agriculture and Sir Edmund Hirst of the chemistry department, supported by grants from the Agricultural Research Council. At that time, a new experimental silo unit had been designed, specifically to study losses, by my immediate supervisor and coauthor, Peter McDonald. This unit was sufficiently sensitive to record a change in weight of one in 10,000, thus making the need for a more ac-

curate dry matter determination more pressing than ever. McDonald suggested that the development of such a method should be one of the objectives in my programme of research for the degree of PhD.

"Initially, an apparatus was designed to simulate the conditions in a forced-draught oven. Using this apparatus,¹ it was possible to identify and determine volatiles after collection at -10°C. While the method gave an accurate picture of losses during oven-drying, it was laborious to use and unsuitable for routine purposes. A possible alternative, if it could be modified, was the well-known distillation technique in which a sample was heated with an excess of toluene and the volume of aqueous distillate measured in a calibrated receiver. Indeed, this method had been used for silage by several workers, but they had not allowed for the volume of volatiles dissolved in the distillate. When such a correction was made for the individual constituents of distillates from silages in our laboratory, the results agreed with those from our oven-drying apparatus. Again the amount of analysis required made the method tedious to carry out, but a time-saving compromise was to calculate a value for volatiles based on a single titration of the distillate with alkali.

"Only a small number of silages examined contained ethanol and then only in small amounts. It is now known that silages preserved with formic acid, where yeast activity is high, can contain larger quantities of ethanol.² Henderson³ has described a modification to the toluene distillation method which takes into account these higher levels of ethanol.

"I have not been involved with silage research since I changed to research on poultry nutrition at the Poultry Research Centre over 20 years ago and I was pleasantly surprised to learn that the method is apparently still widely used. I think that an important factor in the development of the method was the availability of improved analytical techniques which allowed individual volatile compounds to be identified and determined."

1. McDonald P & Dewar W A. Determination of dry matter and volatiles in silage. *J. Sci. Food Agr.* 11:566-70, 1960.
2. Henderson A R & McDonald P. Effect of formic acid on the fermentation of grass and low dry matter content. *J. Sci. Food Agr.* 22:157-63, 1971.
3. Henderson A R. Determination of dry matter in silage. *Edinburgh School Agr. Annu. Rep.* 1978:75.