AGRICULTURE

Amines in Silage

IN 1908 Russell, referred to by Watson¹, reported that silage contained "in addition to ammonia, amines such as pentamethylene diamine, betaine, adenine, and other unidentified purin bodies". Barnett, in his book about silage fermentation², expressed the opinion that putrescine and cadaverine would be present in very poor silages as products of putrefaction.

In the course of work on the chemical composition of grasses and legumes during the ensiling process, silage was prepared in plastic jars (each jar containing about 2 kgm. fresh material) from fresh green maize and lucerne. After 83 days, the maize silage had a pH of 3.8 and showed all the characteristics of normal fermentation. The presence of tyramine was established by chromatography³. Further proof of its identity was obtained by cutting out an area corresponding to the tyramine spot on the chromatogram which was not developed by ninhydrin, and eluting with warm 95 per cent ethanol. The ethanol was evaporated *in vacuo*, and the residue tested for tyramine by the 1-nitroso-2-naphthol reagent⁴.

When fresh green maize was tested for amines before ensilage, no tyramine was found.

Silage from fresh green lucerne was prepared under the same conditions with the further addition of 1.0 per cent sugar. In addition to tyramine at least two more amine spots appeared to be present. One had R_F 0.81 and is possibly phenylethylamine (blue colour when developed with ninhydrin); the other one had R_F 0.50 (brown colour), and might be serotonin. The eluting solvent used was butanol/acetic acid/water (120:30:50).

Tyramine and serotonin are known to exert strong physiological effects in the animal body. The possibility that these amines might interfere with consumption of silage by cattle is under investigation.

H. NEUMARK

Division of Animal Husbandry,
National and University Institute of Agriculture,
Rehovot,
Israel.

¹ Watson, S. J., and Nash, M. J., *The Conservation of Grass and Forage Crops*, 230 (Oliver and Boyd, London, 1960).

² Barnett, A. J. G., *Silage Fermentation*, 119 (Butterworths Scientific Publications, London, 1954).

³ Awapara, J., Davis, Virginia E., and Graham, Odette, *J. Chromatography*, **3**, 11 (1960).

⁴ Udenfriend, S., and Cooper, J. R., *J. Biol. Chem.*, **196**, 227 (1952).

MATHEMATICS

Relationship between the True and Mean Anomalies

For an elliptical orbit, we have the following relations¹:

$$r = \frac{a(1 - e^2)}{1 + e \cos v} \quad \frac{dM}{dv} = \frac{r^2}{a^2 \sqrt{1 - e^2}}$$

whence,

$$\frac{dM}{dv} = \frac{(1 - e^2)^{3/2}}{(1 + e \cos v)^2} \quad (1)$$

where r , a , and e have their usual meanings, and v and M are the true and mean anomalies, respectively.

The solution of equation (1) has been obtained in various ways^{2,3} giving²:

$$M = v + 2 \sum_{n=1}^{\infty} (-1)^n \left\{ \frac{1}{n} + \sqrt{1 - e^2} \right\} e^n \sin n v \quad (2)$$

where $\kappa = \frac{1}{e} \left\{ 1 - \sqrt{1 - e^2} \right\}$, which gives⁴, by

Lagrange's Expansion Theorem⁵,

$$\kappa^n = \left(\frac{e}{2} \right)^n \left\{ 1 + n \sum_{\lambda=1}^{\infty} \frac{(2\lambda + n - 1)!}{\lambda! (\lambda + n)!} \left(\frac{e}{2} \right)^{2\lambda} \right\}$$

As far as terms in e^4 , equation (2) gives³:

$$M = v - 2e \sin v + \left(\frac{3e^2}{4} + \frac{e^4}{8} \right) \sin 2v - \frac{e^3}{3} \sin 3v + \frac{5e^4}{32} \sin 4v$$

A simplified version of the solution to equation (1) enables this expansion to be derived rather quickly.

This solution may be obtained as follows:

We have, from equation (1),

$$\begin{aligned} \frac{dM}{dv} &= (1 - e^2)^{3/2} (1 + e \cos v)^{-2} \\ &= (1 - e^2)^{3/2} \left\{ 1 + \sum_{n=1}^{\infty} (-1)^n (n + 1) e^n \cos^n v \right\} \quad (3) \end{aligned}$$

Now

$$2^{n-1} \cos^n v = \sigma + \sum_{\lambda=0}^{\left[\frac{n}{2} \right]} \binom{n}{\lambda} \cos(n - 2\lambda)v, \quad n > 0$$

where, $\sigma = \frac{1}{2} \binom{n}{\frac{n}{2}}$, for n even

$= 0$, for n odd

and $\left[\frac{n}{2} \right] \equiv$ integral part of $\frac{n}{2}$.

Hence, equation (3) becomes:

$$\begin{aligned} \frac{dM}{dv} &= (1 - e^2)^{3/2} \left[1 + 2 \sum_{n=1}^{\infty} (-1)^n (n + 1) \left(\frac{e}{2} \right)^n \right. \\ &\quad \left. \left\{ \sigma + \sum_{\lambda=0}^{\left[\frac{n}{2} \right]} \binom{n}{\lambda} \cos(n - 2\lambda)v \right\} \right] \quad (4) \end{aligned}$$

But,

$$1 + 2 \sum_{n=1}^{\infty} (-1)^n (n + 1) \left(\frac{e}{2} \right)^n \sigma = (1 - e^2)^{-3/2}$$

Hence, equation (4) becomes:

$$\frac{dM}{dv} = 1 + 2(1 - e^2)^{3/2} \sum_{n=1}^{\infty} \sum_{\lambda=0}^{\left[\frac{n}{2} \right]} (-1)^n (n + 1) \left(\frac{e}{2} \right)^n \binom{n}{\lambda} \cos(n - 2\lambda)v$$

Integrating with respect to v , we obtain the solution in the form:

$$M = v + 2(1 - e^2)^{3/2} \sum_{n=1}^{\infty} \sum_{\lambda=0}^{\left[\frac{n}{2} \right]} (-1)^n (n + 1) \left(\frac{e}{2} \right)^n \binom{n}{\lambda} \frac{\sin(n - 2\lambda)v}{n - 2\lambda} \quad (5)$$

since M and v vanish together.

From this equation, it can be seen that the coefficient of $\sin v$ is: