Stabilization of wet hay by preservatives

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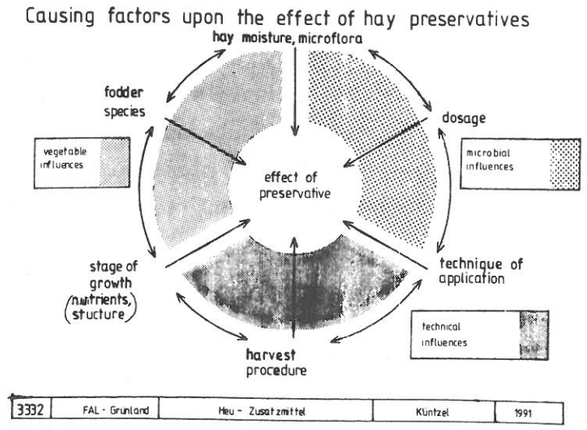
Introduction

In hay stacks with more than 20 % moisture microorganisms are able to grow, predominantly different "storage-fungi" of genus Aspergillus and bacteria of genus Micrococcus. Their metabolism leads to losses and finally to deterioration. Wet hay preserving additives have to inhibit the development of the microflora in hay stacks. Vegetable, microbial and technical factors influence the effect of an additive (fig. 1).

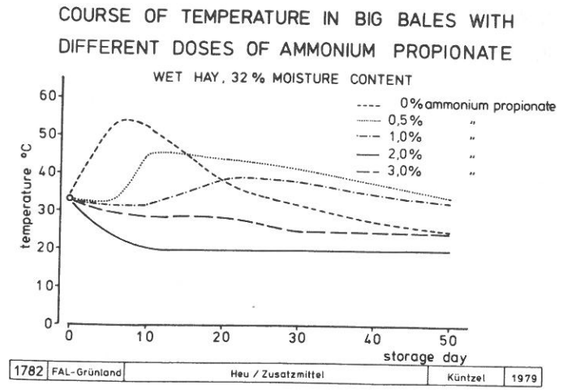
Fig. 1:



Acid preservatives

Propionic acid was the first additive for hay stabilization, which was examined on broad practical scale in the 70ties. Propionic acid and also its derivates could prevent a rise of temperature but in spite of it the hay deteriorated (fig. 2). Due to its volatility the stabilizing effect stays in practice unsatisfactory. A conversion into less volatile, neutral compounds like ammonium-propionate or ammonium-bis-propionate has not improved the preservative effect particularly due to lack of a safe technique for application.

Fig. 2

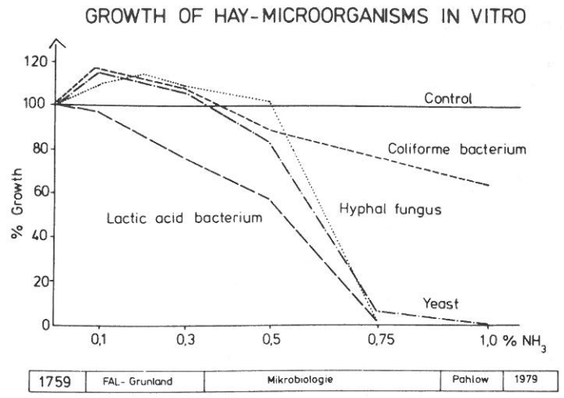


Other acids and their salts had a small growth inhibition effect of hay microorganisms, too. It seems to be especially the undissociated part of an additive that is effective against moulds in hay (see also paper 1b; U.Küntzel: Conservation of unusual substrates). Because the hay-pH is mostly higher than 6 the undissociated part of acids is too small.

Ammonia

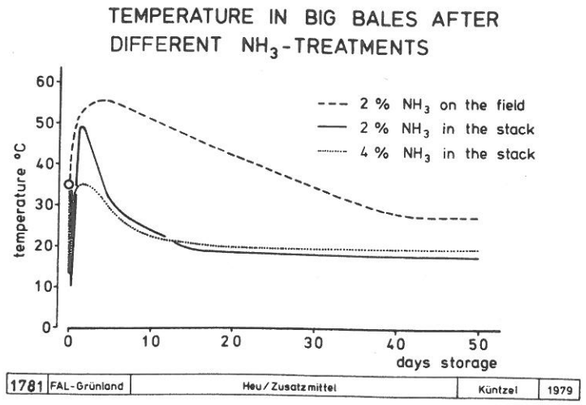
Ammonia (NH_3) is the best investigated preserving additive. Normally, the application is in the form of anhydrous NH_3 under pressure i.e. as liquid NH_3. Growth inhibition of hay microorganisms in laboratory tests could be achieved by 0.75 % soluble NH_3 (fig. 3).

Fig. 3:



In practice the large affinity with water leads to NH_3-solution and solution-heat is set free. This causes a temperature rise up to 80°C (fig. 4) and water evaporation and release of NH_3.

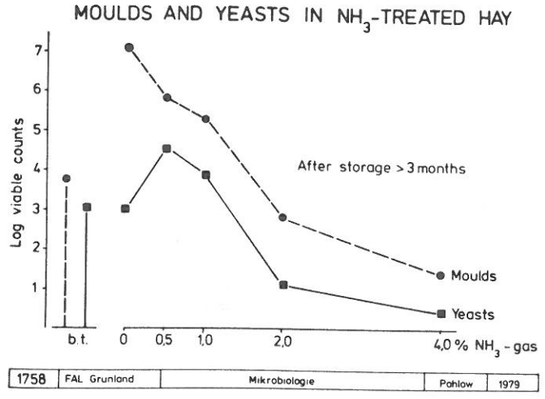
Fig. 4:



Without cover this free NH_3 disappears. Under seal sheet, the water condenses and again the NH_3-gas dissolves. The heat turned out to be the most important factor for NH_3-distribution in hay; covering of the stacks is, therefore, necessary.

53 % of the NH_3-dose are bound with hay and 47 % stay in solution. Less than 1 % of the dose is free NH_3. The minimal inhibition concentration (mic) of 1.6 % liquid NH_3 was calculated and confirmed in practical experiments (fig. 5).

Fig. 5:



Ruminants consume the NH_3-treated hay without difficulty in spite of the strong NH_3-odour (table 1).

Table 1: Feed intake and animal performance from ammonia-stabilized-wet hay

	dairy cattle		fattening cattle	
nature of feed	pasture grass	alfalfa	cocksfoot	Bermuda grass
DM-intake (kg/day·head)				
control hay group	10.2 (100)	11.7 (100)	9.6 (100)	9.8 (100)
NH_3 -hay group	8.5 (81)	11.4 (97)	11.5 (120)	10.0 (102)
Milk performance (kg/day·head)				
control hay group	15.8 (100)	21.7 (100)	—	—
NH_3 -hay group	13.0 (82)	21.4 (99)	—	—
live weight gain (kg/day·head)				
control hay group	—	—	0.53 (100)	0.25 (100)
NH_3 -hay group	—	—	0.69 (130)	0.34 (136)
reference	E.Farries and U.Kantzel (1983)	W.P.Weiss et al.(1982)	K.J.Moore et al.(1983)	P.R.Utley et al.(1978)

Urea

The conservation effect of urea is based on its solution in water and the following breakdown to NH_3 in the presence of the enzyme urease. The necessary urea dose for wet hay stabilization is determined by the solved part of urea, the degree of urea hydrolysis and the amount of NH_3 which is going into solution. 56.7 parts of NH_3 arise from 100 parts urea. Here, the soluble portion of NH_3 seems to be constant, but depends on the moisture content of the hay. Accordingly, the calculated mic-dose of hay with 24 % moisture is 7 % urea but wet hay with 30 % moisture only needs 2.4 % urea.

The technique for urea application is still unsatisfactory; no feeder are offered on the market. Apparently, it is possible to feed ruminants with urea-treated wet hay without problems.

References

Küntzel, U. (1991): Stabilisierung von feuchtem Heu durch Konservierungsmittel. Übers. Tierernährung (in press)