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Moist Grain Preservation in a Silage Bag

A well known method from the 1970's using bagging machines to preserve forage in silage bags has been further developed for moist grain. Since 2005 it has been used for storing moist grain on farms. Preliminary investigative results for this procedure are presented in the following.

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Keywords

Moist grain, silage bag, fermentation quality, aerobic stability, silage additive

Literature

Literature references can be called up under LT 06315 via internet http://www.landwirtschaftsverlag.com/landtech/local/literatur.htm.

In Germany, 50 to 85% of grain is usually threshed at a moisture content of more than 14% W.B., i.e. in a state in which the grain cannot be stored. In agricultural practice, the grain is usually made storable by reducing its moisture content to below 14 % by hot air drying. For grains with higher moisture contents, however, steadily rising energy costs are increasingly calling the viability of this method into question.

A new variant of the tube silo method, in which fresh grain with a high moisture content is crimped, sprayed with a silage additive if necessary, and pressed into a silo bag in a single operation, was tested in practical experiments and in the laboratory.

Material and Methods

During the 2005 harvest two silage bags were filled with crimped wheat. The aim of the experiment was to analyse the influence of the moisture content of the wheat and of the application rate of a silage additive on the fermentation quality and the stability of the material in the silo bags. Material with moisture contents of 18 percent (low moisture, LM) and 30 percent (high moisture, HM) was used; two-thirds of it was treated with two different application rates of a silage additive designed to improve aerobic stability during feed out. Half of the material was moistened in a vertical feed mixer before bagging. In both silage bags, sections of five meters were reserved for each application rate of the silage additive, whereas the first five-meter section of each bag, filled with material without silage additive, served as a control. In the second and third sections of the HM bag, the silage additive was applied at four and two litres per tonne fresh matter (FM). The application rates were doubled to four and eight l/t FM respectively for the LM variants in the second silage bag because the lower moisture contents were expected to result in less favourable fermentation and storage conditions than in the HM variants [2]. A modified 'buried bag' method using temperature loggers in fine mesh bags was used to determine the fermentation quality, the fermentation losses, and the temperature course in the bags over a storage period of 50 days [3]. Through flaps installed in the back wall of the bagging tunnel specifically for this purpose, the mesh bags with the temperature loggers were embedded at the centre and at the periphery of the material in the silage bags. They were removed after 50 days. After backweighing, samples from these mesh bags were examined for fermentation quality parameters and microbial activity.

In order to analyse the aerobic stability of the wheat in the silage bags, samples were taken from all mesh bags and stored under aerobic conditions in a climatic test cabinet.

Laboratory experiments

In order to examine the variants in a standardised manner in accordance with the relevant guidelines of the DLG (German Agricultural Society) [4], several series of experiments were prepared in addition to the silage bags by taking material from the silage bags during bagging and storing it in

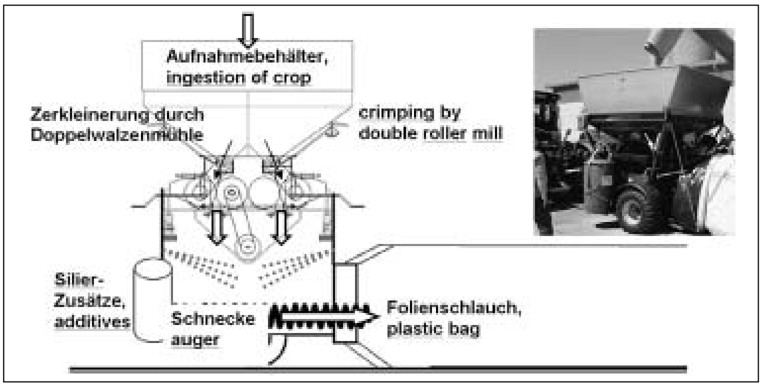

Fig.1: Drawing of an ensiling unit with integrated crimper bagger

mini silos (1.5 l jars). The aim was to determine the fermentation quality, the aerobic stability, and the decrease of the pH-values of these samples, parallel with the practical experiments.

In addition to the standard method, the material from the mini silos and the material from the mesh nets was stored under aerobic conditions in a climatic exposure chamber after 90 days (mini silos) and 50 days (buried bag) respectively, and the temperature course of the material was recorded. Based on figures reported in the relevant literature [4, 5, 6], the critical temperature for the beginning of aerobic degradation was defined as any temperature 2 K above ambient temperature.

Laboratory experiments with a materials testing machine were conducted to facilitate the assessment of the compressibility of the crimped wheat. The compressibility tests followed the same procedure as earlier compressibility tests carried out with chopped maize [7].

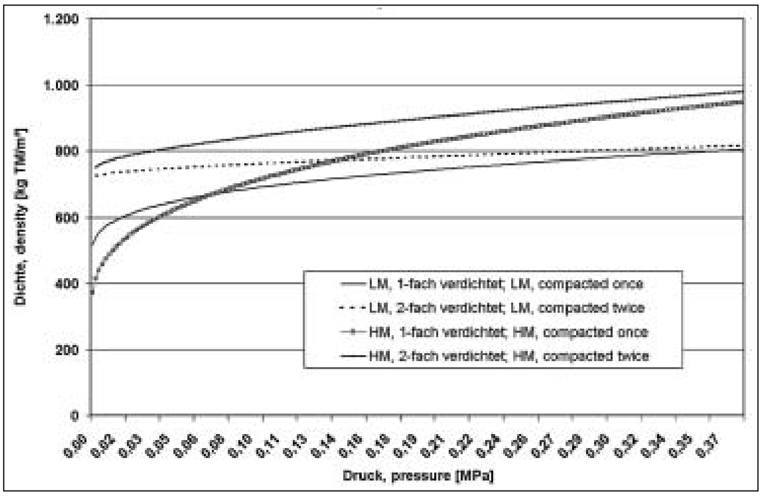

Fig. 2: Compressibility of crimped wheat with moisture contents of 18 % (LM) and 30 % (HM)

Results and discussion

The results of the fermentation quality analysis (*Table 1*) confirmed both our expectations and the results reported for other storage methods for moist grain [8]. The wheat with an average moisture content of 18 percent showed no appreciable signs of fermentation. Still, the grain in the sealed silage bag had been preserved due to the effect of the carbon dioxide produced from the oxygen left in the silos after sealing.

The small amounts of lactic acid and acetic acid formed by the fermentation of the HM wheat with a moisture content of 30% were sufficient to lower the pH-value to 4.2. Very low NH_4-N levels are an indicator of an early completion of the fermentation processes. The absence of butyric acid and very low ethanol contents, which can be reduced even further by applying more silage additive, is an indicator of the high quality of the silage.

Neither under laboratory conditions nor in the practical tests did the mass balance method used here [9] produce clear evidence of a dry mass loss of the moist grain during storage.

Except for the LM variant, under the constantly anaerobic conditions in the silage bag, the microbial levels never reached critical values [10]. It must be stressed that, in contrast to the microbial levels determined in the laboratory, which exceeded the limit values only in the control variants, neither of the variants treated with the silage additive nor the untreated HM variant in the silage bag contained significant microbial levels.

These results were confirmed in the determination of aerobic stability, because the untreated HM variant showed no signs of heating, either after anaerobic storage in the silage bag (50 days) and in the mini silos (90 days) with subsequent aerobic stress in the climatic exposure test cabinet, or in the untreated section of the HM silage bag after opening. By contrast, the aerobic stability of LM wheat without silage additive was very low at only three days in the opened silage bag and two days in the laboratory. At both moisture contents, application rates of silage additive of 2 l/ t FM in the laboratory resulted in a high level of aerobic stability, which was not significantly improved by higher application rates. This has not been verified yet for the opened silage bag.

The results of the compressibility tests are presented in a pressure/density diagram (*Fig. 2*). Evidently, the crimped LM wheat is less compressible than the HM variant. At a pressure of 0.38 MPa, densities of more than 800 kg DM/m^3 (LM) and 950 kg DM/m^3 (HM) were recorded. Leading to a significant improvement of its aerobic stability, the better compressibility of moist grain plays a major role in keeping feed quality at a high level.

Parameter		LM			HM		
		0-Liter	4-Liter	8-Liter	0-Liter	2-Liter	4-Liter
pH-Wert	$\bar{x}$	6,5	6,0	5,6	4,2	4,2	4,1
	s_x	0,1	0,1	0,2	0,1	0,0	0,0
Milchsäure [g/kg TS]	$\bar{x}$	0,0	0,0	0,0	16,8	10,1	13,2
	s_x	0,0	0,0	0,0	4,1	2,3	1,7
Essigsäure [g/kg TS]	$\bar{x}$	0,0	0,0	0,0	6,1	4,6	4,2
	s_x	0,0	0,0	0,0	2,0	1,5	1,0
Propionsäure [g/kg TS]	$\bar{x}$	0,9	2,3	4,6	1,1	1,4	2,5
	s_x	0,1	0,5	1,1	0,4	0,3	0,5
NH4-N [mg/kg TS]	$\bar{x}$	68,3	61,0	64,6	532,1	537,0	548,1
	s_x	8,1	0,9	6,5	88,7	51,1	64,7
Ethanol [g/kg TS]	$\bar{x}$	1,1	0,2	0,1	2,8	1,7	1,5
	s_x	0,5	0,1	0,1	0,5	0,3	0,3

Table 1: pH-values and contents in fermentation products in wheat after 50 days of storage in a plastic bag

Lagerort (anaerob)	Schlauch											
Feuchte [%]	18			30			18			30		
Lagerdauer	50 Tage Kern (anaerob)						50 Tage Rand (anaerob)					
Siliermittel [l/t FM]	0	4	8	0	2	4	0	4	8	0	2	4
Aerobe Stabilität [Tage]	13	13	13	13	13	13	2	13	13	13	13	9
s_x	0	0	0	0	0	0	3	0	0	0	0	2

Table 2: Aerobic stability of wheat after 50 days of anaerobic storage in a silage bag and aerobic storage in a climatic test cabinet afterwards

Conclusion

Silage bags are a viable alternative to conventional storage methods for feed grain. There is no silage fermentation at a moisture content of 18%, and without silage additives aerobic stability poses a problem. Fermentation was shown to have occurred at a moisture content of 30%. Initial results indicate that the material remains sufficiently stable under aerobic conditions even without silage additives, which is probably due to the better compressibility of the material and to the fact that silage fermentation has occurred. The effect of the silage additive on the aerobic stability in the silage bag must be explored further. The practical and laboratory experiments are being continued.