FOAM FOR COVERING SILAGE: OPPORTUNITIES AND LIMITATIONS

Knicky, M.[1], Melin, P.[1]

[1]RISE-Research Institutes of Sweden, Detp. of Agriculture and Environmental Engineering, Ultunaallén 4, Uppsala, Sweden

ABSTRACT

Conventional covering of bunker silos relies on plastic films to maintain anaerobic conditions during ensiling. This method is labour-intensive and generates substantial plastic waste. A foam-based sealing method developed at TFZ research centrum in Germany has been proposed as an environmentally friendly alternative. The foam is biodegradable, feed-safe, and potentially applicable both immediately after silo filling and during feed-out. This study evaluated the foam's functional performance under laboratory condition, focusing on sealing ability, required thickness, fermentation outcomes and aerobic stability. Laboratory glass silos and simulated feed-out tubes were used. Results show that foam thickness strongly affects mould exclusion, which reduced fermentation efficiency and resulted in higher losses compared with air-tight controls. During feed-out simulation trail, foam reduced aerobic spoilage and weight losses. Study suffered from practical limitations in form of missing application device. Proper application appears critical, especially regarding uniform thickness. Further technological development is required before practical implementation.

Keywords: silage sealing, foam covering, aerobic deterioration, fermentation quality

INTRODUCTION

A successful ensiling process is associated with low losses, as lactic acid bacteria efficiently convert substrates into fermentation products, while other undesirable microorganisms are less efficient and therefore cause greater fermentation losses (McDonald *et al.*, 1991). Studies have shown that silage losses in bunker silos can be high, reaching up to 26% of dry matter (Spörndly and Nylund, 2016). These high losses are largely due to handling during filling and feed-out (Muck and Holmes, 2000). Today, plastic films are used to cover silage and thereby maintain anaerobic conditions. The conventional method of covering the silo with plastic films is labor-intensive and involves potential safety risks during covering and uncovering. In addition, recycling and disposal of the film after use is laborious and problematic from an environmental perspective. In Germany, the Technologie- und Förderzentrum institute (TFZ) has developed a spray-on foam composed of natural oils, fibres, alginate, and natural rubber. Once applied, the foam hardens into an elastic surface that adheres to the silage mass and can be removed mixed with the feed. The concept appears promising, but its effectiveness, required thickness, and suitability under Nordic conditions remain unclear. This study aimed to evaluate the potential and limitations of the foam method for bunker-silo sealing and feed-out protection.

MATERIAL AND METHODS

The foam consists of two main fractions that are mixed together immediately upon application. Each component consists of several raw materials that are mixed separately. The foam consisted of rapeseed oil, sodium alginate, cellulose fiber, calcium sulfite in one fraction, and natural rubber, water, sodium benzoate, sorbic acid, glycerol in second fraction. The foam is intended to be spray-applied to the surface of the silo. Unfortunately, a lack of the necessary equipment meant that the foam in this experiment was applied using a pouring method. Grass–legume herbage (third cut) was wilted to 35% DM and chopped to 3 cm length was used. Two types of experiments were designed, both without silage additive application. In the storage trial three foam thicknesses (9, 17, 21 mm) were compared with a control sealed with airlock only. For this purpose, 1.7 L laboratory silos were used, and forage was packet at density of 167 kg DM/m³. In the feed-out simulation trial, two PVC tubes (11 cm × 1.8 m) were filled with wilted forage at density of 168 kg DM/m³. All silos were stored at 3–21 °C for 180 days. After the storage, silages were analyses for chemical and microbial composition. Tube silos were cut by 15 cm weekly to simulate slow feed out at 20 °C. One column was foam covered after each removal: the other remained uncovered. Weight losses, temperature, mold, yeast and chemical composition were monitored in removed silage fractions.

RESULTS AND DISCUSSION

Results from storage trail are presented in Table 1. Overall fermentation quality of silages was poor across all treatments, mainly due to low water-soluble carbohydrate content and high buffer capacity of the forage. All silages showed high pH and low lactic acid production, indicating dominance of heterofermentative lactic acid bacteria. Mould growth declined with increasing foam thickness, and at ~17 mm mould was fully excluded. This requirement differs from TFZ recommendations (5–8 mm), potentially due to poorer application quality from manual pouring. However, yeast populations remained high in all foam treatments. Silage losses were greater in foam-covered silos compared with the control. Some losses were likely caused by evaporation of water from the foam, which contains ~20% moisture.

Results from feed-out simulation trial howed that foam covering during feed-out reduced aerobic spoilage substantially (Table 2). The foam-covered tube exhibited lower temperature increases, lower aerobic microbial growth and markedly reduced weight losses compared with the uncovered control. Differences in temperature were exibited from third week of exposure. These results show promise for foam as a feed-out barrier, especially during prolonged removal intervals.

CONCLUSION

Foam as a silage cover shows potential, particularly for protecting exposed surfaces during feed-out where it reduced aerobic losses. However, without a proper equipment foam did not achieve fermentation quality comparable to air-tight control. Proper application appears critical, especially regarding uniform thickness. Before foam can serve as a practical or economic alternative to plastic film, improved application technology, cost reduction and further optimisation are required.

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Tab. 1: Chemical and microbial composition of silage in the foam-thickness test (n=3). Control = lid with fermentation lock; Foam 1 = 0.9 cm; Foam 2 = 1.7 cm; Foam 3 = 2.1 cm

Analyses	Unit	Treatment				LSD*	P-value
		Control	Foam 1	Foam 2	Foam 3		
DM	%	34.7	34.9	35.1	34.6		
pH		5.2	5.3	5.2	5.2	0.18	0.2
NH3-N	% total N	8.0c	8.4^{b}	8.9^{a}	9.1^{a}	0.32	0.001
Lacic acid	% DM	1.9^{b}	2.2^{b}	2.4^{b}	3.8^{a}	1.07	0.02
Acetic acid	% DM	0.4^{a}	0.2^{b}	0.3^{b}	0.3^{b}	0.06	0.004
Propion. acid	% DM	0.6^{b}	0.5^{a}	0.6^{b}	0.7^{b}	0.10	0.02
Butyric acid	% DM	<0.05	<0.05	<0.05	<0.05	0.11	0.3
Ethanol	% DM	0.8^{a}	0.4c	0.5^{b}	0.6^{b}	0.08	0.001
2.3-^{b}utandiol	% DM	0.6	0.6	0.5	0.6	0.16	0.3
Yeast	log cfu/g	1.7^{a}	4.2c	4.2c	3.9^{b}	0.22	0.001
Moulds	log cfu/g	1.7^{b}	4.3^{a}	2.7^{b}	1.7^{b}	1.36	0.01
Weight losses	% DM	4.7^{b}	16.4^{a}	15.4^{a}	15.3^{a}	6.87	0.001

Means in the same column with different uppercase letters differed (P <0.05). *Least signifiant difference.

Tab. 2: Silage quality during feed-out simulation test (n=1)

Treatment	Exposure	DM (%)	pH	Weight losses	Moulds	Yeasts
	time			% DM	log cfu/g	
Foam	1st week	34.5	4.9	0.3	<1.7	5.8
Control		35.8	5.0	2.1	<1.7	5.8
Foam	2nd week	34.6	5.0	0.9	<1.7	6.3
Control		36.2	5.1	4.0	<1.7	6.2
Foam	3rd week	34.4	5.0	1.2	3.5	6.2
Control		35.1	5.2	6.2	5.4	7.0
Foam	4th week	34.5	5.0	1.5	4.2	5.9
Control		32.5	8.1	9.1	8.0	8.0
Foam	5th week	34.5	5.0	1.7	5.2	7.0
Control		34.4	5.6	11.4	6.0	7.2

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Contact Information

Knicky Martin: e-mail: martin.knicky@ri.se