CHANGES IN LACTIC AND ACETIC ACID, PH, DRY MATTER AND TEMPERATURE DURING AEROBIC DETERIORATION

Zielke, J.[1], Korn, U.[1], Pieper, B.[1]

[1]Dr. Pieper, Technologie- und Produktentwicklung GmbH, Dorfstraße 34, 16818 Wuthenow, Germany

Abstract

Oat whole crop silage was produced in glass jars with addition of homofermentative lactic acid bacteria, yeast and 1% or 2% of acetic acid. Jars were opened after and 49 days. On days 1 to 7 of exposure to air, lactic acid, acetic acid, pH and dry matter were measured daily. Temperature was measured continuously. The addition of acetic acid delayed aerobic spoilage. Dry matter, lactic acid and acetic acid decreased during aerobic deterioration, whereas temperature and pH increased. However, the rise in pH was delayed compared to the temperature rise. The drop in fermentation acid and dry matter can only be determined by destructive measures and are not suitable for routine spoilage control. Therefore, the rise in temperature remains a sensitive and early parameter for the detection of silage deterioration.

Keywords: oat silage, acetic acid, aerobic deterioration

INTRODUCTION

An aerobically stable, high-quality silage is essential for high milk-yield and animal health. Therefore, it is necessary to know the biological and chemical processes during aerobic deterioration. Frequently, a rise in temperature is being reported during aerobic deterioration, but other parameters like lactic, acetic acid, pH, and dry matter content are also affected. A high yeast count can have a negative impact on aerobic stability. Therefore, preservatives which inhibit yeasts are applied to avoid aerobic spoilage.

The objective of this study was to investigate changes in lactic acid, acetic acid, pH, temperature and dry matter as early predictors of spoilage in silage during aerobic deterioration.

MATERIAL AND METHODS

Oat whole crop silage was produced in 1.5 L glass jars. The forage was inoculated with lactic acid bacteria (LAB) composed of Lactiplantibacillus plantarum DSM 8862 and DSM 8866 at a rate of 3×10^5 CFU/g FM. (BIO-SIL®, Dr. Pieper Technologie- und Produktentwicklung GmbH, Germany). To increase the number of acid-degrading yeasts, Pichia kudriavzevii (YEA) were added (1×10^6 CFU/g FM). Acetic acid (AA) was added at 10 g or 20 g/kg FM (see Table 1).

Jars were opened after 10 and 49 d. On days 1 to 7 of exposure to air, lactic acid, acetic acid, pH, and dry matter were measured daily. Temperature was measured continuously (wireless).

RESULTS AND DISCUSSION

The nutrient content of the ensiled oat (*Avena sativa L.*) corresponds to a typical oat at the beginning of the dough-ripe stage (Jeroch *et al.*, 1993). The starting material was in the range of moderate to easy-to-ensile fodder with a high dry matter content (DLG, 2011). The nitrate content was below the optimum range (Table 2).

Dry matter, lactic acid and acetic acid decreased during aerobic deterioration, whereas temperature and pH increased. After 10 d of ensiling, the addition of yeast caused an accelerated aerobic deterioration by 0.8 days (CON vs CON + YEA) and 2.2 days (AA1% vs AA1% + YEA; data not shown) whereas after 49 d of ensiling, there was no effect of addition of yeast observed in any group (Figure 1). On day 49 of ensiling, the addition of 1% acetic acid to the forage delayed aerobic deterioration by 1.2 days. When adding 2% acetic acid to the forage, silages were stable over 7 days after 10 and 49 days of ensiling even when challenged with lactate assimilating yeasts.

In all cases of aerobic deterioration, lactic and acetic acid decreased at the same time as the rise in temperature. The increase of pH-value was delayed by 1 to 2 days.

Tab. 1: Ensiling of oat using lactic acid bacteria (LAB) composed of *L. plantarum* DSM 8862 and DSM 8866 and acetic acid (AA) as a chemical preservative. To group B, D, and F, lactate assimilating yeasts of the species P. kudriavzevii (YEA) were added. FM = fresh matter

Group	Name	Inoculation density LAB [CFU/g FM]	Inoculation density YEA [CFU/g FM]	Acetic Acid [g/kg FM]
A	CON	3×10^5	–	–
B	CON + YEA	3×10^5	1×10^6	–
C	AA1%	3×10^5	–	10
D	AA1% + YEA	3×10^5	1×10^6	10
E	AA2%	3×10^5	–	20
F	AA2% + YEA	3×10^5	1×10^6	20

Tab. 2: Forage characteristics of the fresh harvested oat (*Avena sativa L.*). BC = buffering capacity; FC = fermentation coefficient. FM = fresh matter, DM = dry matter)

Dry matter [g/kg FM]	Crude ash [g/kg DM]	Crude protein [g/kg DM]	Crude fibre [g/kg DM]	Crude fat [g/kg DM]	Sugar [g/kg DM]	Starch [g/kg DM]	BC [g/kg DM]	FC	NO_3 [g/kg DM]
380	57	59	235	40	57	218	17.1	64	1.1

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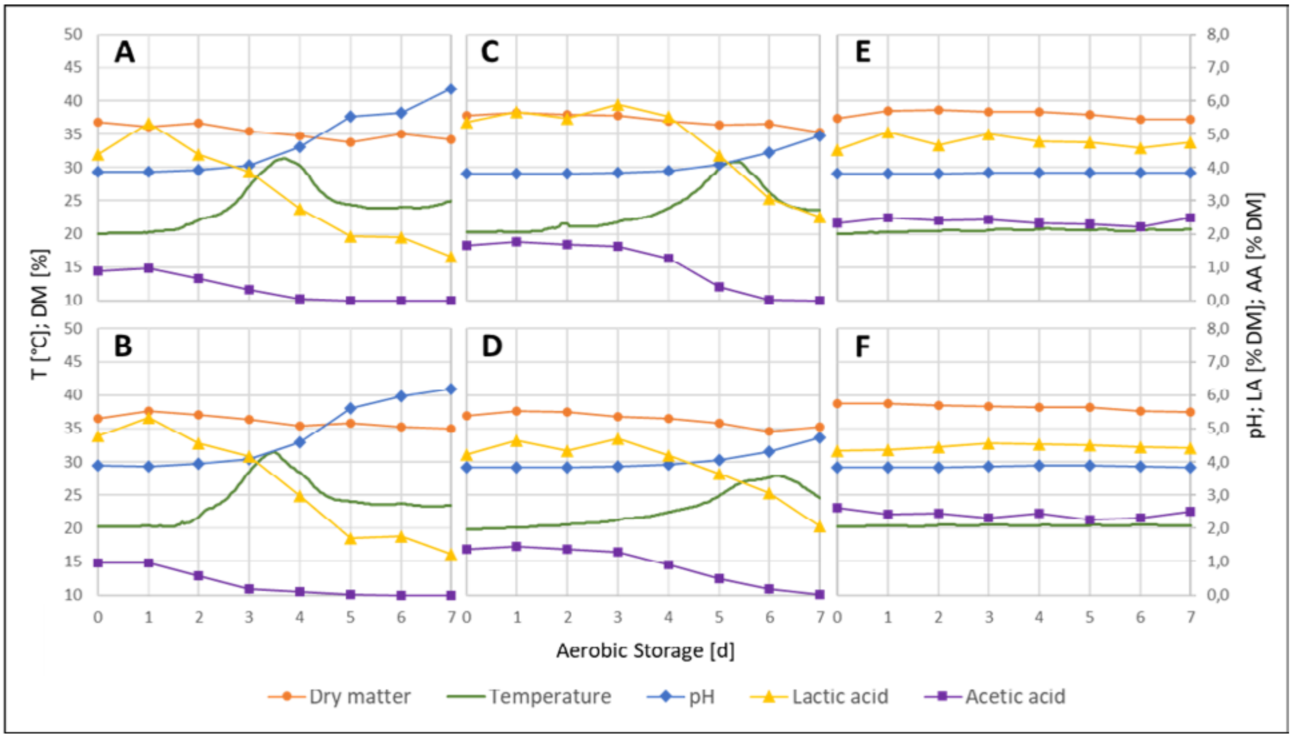

Fig. 1: Temperature and pH profile as well as dry matter (DM), lactic acid (LA), and acetic acid (AA) content during aerobic storage of oat silage inoculated with 3×10^5 CFU *L. plantarum*/g fresh matter (FM) after 49 days of ensiling. A and B: Without addition of AA; C and D: addition of 10 g AA/kg FM; E and F: addition of 20 g AA/kg FM. Upper row: without addition of lactate assimilating yeasts (YEA); bottom row: with addition of 10^6 YEA/g FM (*P. kudriavzevii*).

CONCLUSION

The drop in fermentation acid and dry matter can only be determined by destructive measures and are not suitable for routine spoilage control. Therefore, the rise in temperature remains a sensitive and early parameter for the detection of silage deterioration.

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Contact Information

Jutta Zielke: e-mail: zielke@dr-pieper.com