Use of Optical pH-Measurement in Early Silage Fermentation Trials

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Introduction

- Testing pH-value within the first few days of silage fermentation trails gives valuable information about the ensiling process.
- However, samples cannot be taken without opening the experimental jars, requiring additional repetitions per desired sampling time.
- Optical, non-invasive pH-measurement has been developed by PreSens Precision Sensing GmbH (Regensburg, Germany) and tested in various experimental settings (Koop-Jakobsen et al., 2018, Reinders et al., 2019).
- The objective of this pilot study was to assess, whether optical pH measurement with self-adhesive sensor spots (PreSens Precision Sensing GmbH, Regensburg, Germany) is feasible for the use in laboratory silage trials.

Methods

- Sensor spots were attached to the inner bottom of 0.5L glass jars (Figure 3).
- The trial was conducted over 4 days including 6 treatment groups with 3 repetitions each (Table 1)

Table 1. Treatment groups with different proportions of *L. buchneri* and *L. plantarum*. Inoculation density (group 2 to 6): 3•10^5 CFU/g FM; ensiling material: perennial ryegrass (*Lolium perenne*) and oat-grass (*Arrhenatherum elatius*); dry matter (DM) content: 39%; sugar concentration: 14.1% DM

Species	Group					
	1/Control (n = 3)	2 (n = 3)	3 (n = 3)	4 (n = 3)	5 (n = 3)	6 (n = 3)
L. buchneri [%]	-	94	85	70	50	0
L. plantarum [%]	-	6	15	30	50	100

- On day 0 and day 4, pH was measured in aqueous solution as described in Tabacco et al. (2009) and on day 4 with an insertion electrode (FiveEasy Plus, Mettler-Toledo GmbH, Gießen, Germany).
- On days 0 to 4, pH was measured daily by optical measurement using pH-1 SMA LG1 (PreSens Precision Sensing GmbH, Regensburg, Germany) through the glass wall of the jar.

Results

- Between 6h and 24h after ensiling, a steep decrease in pH-values was observed using the optical pH measurement (Figure 1).
- Between 24h and 96h pH-values decreased only slowly.
- Standard deviations of optical measurement were greater than in aqueous solution.

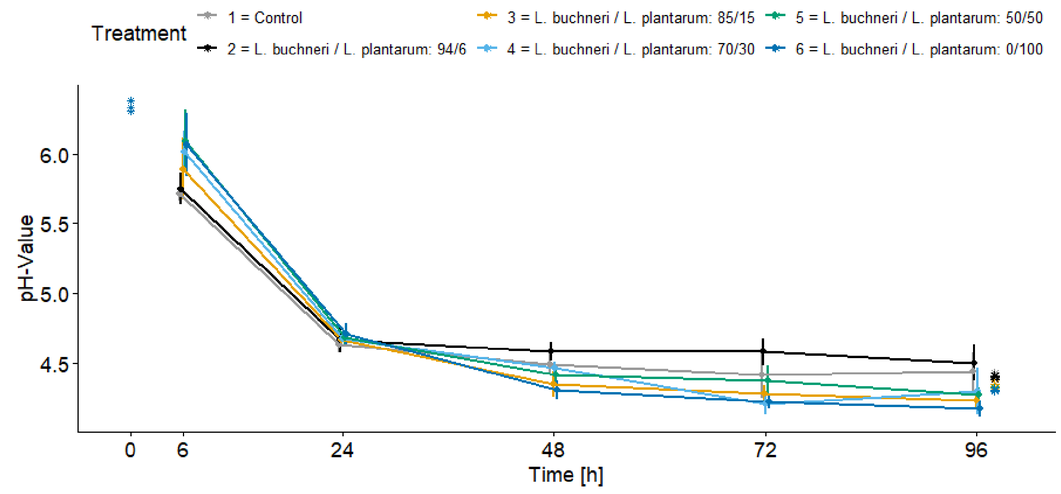

Figure 1. pH-value measured in a silage trial over 4 days. Measurements at 0h and 98h (stars) were taken in aqueous solution and measurements at 6h, 24h, 48h, 72h, and 96h (lines) were taken using an optical probe. Treatments 2-6 varied in the proportions of *L. buchneri* and *L. plantarum* in silage additive e.g. treatment 2 was comprised of 94% *L. buchneri* and 6% *L. plantarum*.

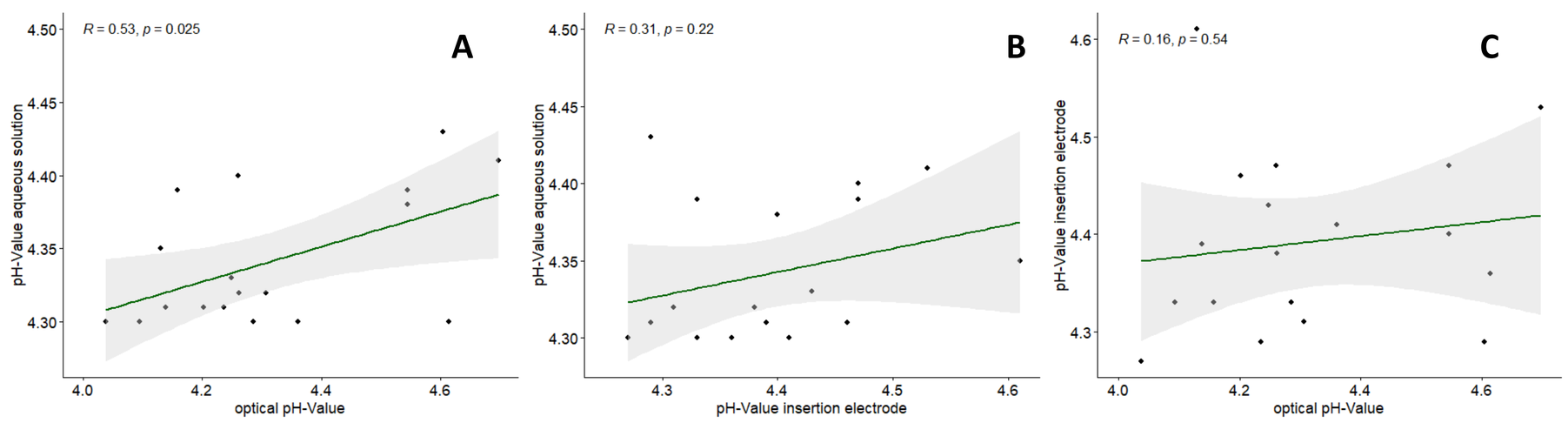

Figure 2. Pearson correlations among three pH-measurement methods on day 4 of silage trial.

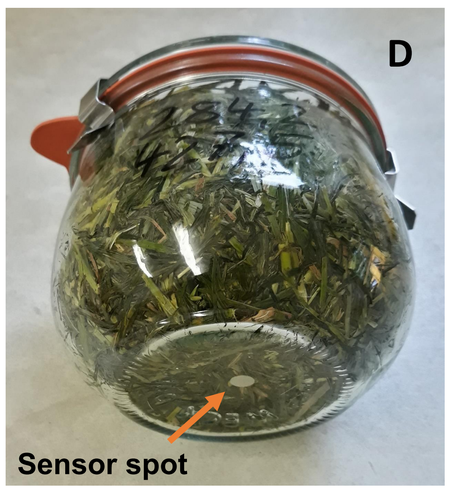

Figure 3. Placement of PreSens sensor spot in experimental jars.

Conclusions

- Optical pH measurement is a novel opportunity to describe the ensiling process, in the early phase of fermentation.
- The advantage is that for pH-measurement, the laboratory silo does not have to be opened and more data points can be measured with fewer replicates.
- The description of the pH in the early fermentation phase could be performed, for example, every minute, if desired.
- On the other hand, the ensiling material is inhomogeneous and therefore, the surface touching the sensor spot might have a range of pH-values.
- Further studies should test this new optical pH-measurement technique using different dry matter contents, chopping lengths and ensiling materials.

References Koop-Jakobsen K, Mueller P, Meier RJ, Liebsch G, Jensen K. Plant-Sediment Interactions in Salt Marshes - An Optode Imaging Study of O2, pH, and CO 2 Gradients in the Rhizosphere. Front Plant Sci. 2018 May 3;9:541.
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