THE EFFECT OF DIFFERENT DRY MATTER CONTENT ON THE FERMENTATION PROCESS AND AEROBIC STABILITY OF ALFALFA SILAGE

Doležal, P.[1], Hendrychová, K.[1], Jambor, V.[2], Juráček M.[3], Šimko, M.[3], Havlíček Z.[1], Dvořáček, J.[4], Pazdera, J.[5]

[1]Mendel university in Brno, Zemědělská 1665/1, 613 00 Brno, Czech Republic
[2]Nutrivet Ltd., Vídeňská 1023, 691 23 Pohořelice, Czech Republic
[3]Slovak University of Agriculture in Nitra, Trieda A. Hlinku 2, 94976 Nitra, Slovak Republic
[4]Association of Professional Services, Ltd., 67901 Skalice nad Svitavou, Czech Republic
[5]KWS Seeds, Ltd., Pod Hradbami 2004/5, 594 01 Velké Meziříčí, Czech Republic

ABSTRACT

The aim of this study was to determine the effect of different dry matter contents of ensiled alfalfa on fermentation quality and the resulting aerobic stability. Alfalfa was ensiled in PE bags and treated with an additive containing a lactic acid bacteria inoculant and an aromatic salt. The quality of the fermentation process was assessed by determining the fermentation products and nutritive value according to Commission Regulation (EU) 771/2024. Aerobic stability was assessed by continuous temperature measurement in a measuring device. The critical temperature for the onset of aerobic instability was defined as the point at which the silage temperature increased by more than 3 °C. It was found that increasing dry matter content, the production of all fermentable acids, including lactic acid, decreased, and protein degradation (%degree of proteolysis) decreased. The aerobic stability of the tested operational alfalfa silages lasted 125-135 hours from air exposure. It has been confirmed that high-quality primary fermentation (Quality class II) is only one of the factors influencing the resulting aerobic stability, which adds to the complexity of this issue.

Keywords: alfalfa silage, dry matter content, fermentation quality, aerobic stability

INTRODUCTION

The dry matter content of alfalfa (*Medicago sativa*), or rather the dry matter composition of this silaged forage, has a fundamental influence on the resulting quality of the fermentation process, as well as the intake of the finished silage. The lack of fermentable carbohydrates in silaged alfalfa is technologically solved by increasing the dry matter content through intensive silage to a value of 40–45%, although the largest volume of alfalfa silages in our country is produced in the dry matter range of 35–40%. It is known that increasing the dry matter content improves the conditions for fermentation in favour of lactic fermentation. It is known that silage above 50% dry matter does not have a positive effect on feed intake, but in addition, technological problems arise with trampling of the silaged material, microbial heating and mould. When silage is silaged for more than 48 hours, nutrient losses of over 10% occur. Quality changes are also related to the proportion of leaves and stems in the material. The proportion of leaves also varies with the order of mowing, is related to the density of the stand and also decreases with the age of the stand. Šimko et al. (2006) report that the proportion of leaves in the early phase of the first mowing is in the range of 42–48 %, while in the second mowing it drops to a lower value (28–45 %).

MATERIAL AND METHODS

Alfalfa stands were harvested at the end of budding, bundled and subsequently harvested and ensiled using the technology of pressing into PE bags with the addition of a combined microbial-chemical silage additive at a dose of 1l/ton of matter. The additive contained five strains of homofermentative lactic acid bacteria and potassium salt of sorbic acid. Alfalfa was harvested on a farm in the Veľké Uherce area in the Trenčín Region in the Partizánske District. Veľké Uherce is located at an altitude of approximately 220 m above sea level with an annual precipitation of approximately 600–700 mm. The operational experiment was aimed at evaluating the qualitative and nutritional characteristics of alfalfa haylage depending on the dry matter content. At the same time, silage samples were assessed for aerobic stability according to the Honig methodology (1990) based on the course of changes in silage temperature after opening. The obtained data were statistically processed and evaluated using the Tibco Statistica CZ program. One-factor variation according to ANOVA was used in the data evaluation, and the statistical significance of the differences was tested using the Scheffe test at a significant level of $p < 0.05$.

RESULTS AND DISCUSSION

Selected indicators of the fementation process of the evaluated alfalfa silages are listed in Table 1.

The average dry matter content of the operational alfalfa silages was 422.3 ± 116.4 g.kg^{-1}, which corresponds to the optimal range for alfalfa silages, in which high-quality fermentation occurs simultaneously with minimal losses. This is also confirmed by the study of Li *et al.* (2018), who achieved similar results. However, there was a relatively high variability in dry matter content between individual samples (from 330.2 to 639.9 g/kg). The positive effect of treatment with a microbial-chemical additive on the quality of the fermentation process is also confirmed by Ding *et al.* (2011) and Peng *et al.* (2024). The average pH value (4.61 0.09) was within the optimal range for alfalfa silages, from which it can be concluded that the silage mass was sufficiently acidified, with

Tab. 1: Average fermentation characteristics (n = 6)

DM	pH	TA	LA	AA	LA/VFA	∑ acids	DP	Ethanol
%		mg KOH/100 g	%					
422.3±116.4	4.61±0.09	1167.67±391	2.18±0.49	0.66±0.17	1.31±0.02	7.40±2.80	6.30±0.65	0.04±0.02

DM... Dry matter, TA... Titrate acidity, LA... Lactic acid, AA... Acetic acid, DP... Degree of proteolysis

Tab. 2: Average nutritional value of lucerne silage (in DM)

CP	RDP	CF	ADF	NDF	DCF	NFC	DMD	NEL
g.kg^{-1}	%	g.kg^{-1}			%	g.kg^{-1}	%	MJ
198.9 ±8.7	74.73±1.78	282.5±17.4	328.6±13.2	358.7±10.4	21.61±4.07	282.6±15.6	65.24±1.53	4.30±0.04

CP... Crude protein; RDP...Rumen degradability of protein; CF... Crude fiber; ADF...Acid detergent fiber; NDF...Neutral detergent fiber; DCF... Rumen degradability of CF; NFC... Non-fiber carbohydrates; DMD... Digestibility of dry matter; NEL... Netto energy of lactation

https://doi.org/10.11118/978-80-7701-093-1-0148

the exception of the silage with the highest dry matter content (633.9 g/kg), which showed insufficient acid content and high pH values. Hashemzadeh-Cigari *et al.* (2014) also state that a high-quality fermentation process takes place at a pH of 4.5 or less. The average lactic acid content was 2.18 ± 0.49%, which corresponds to the results of Gua *et al.* (2019), who found 2-3% of this acid in the analysed samples. The lowest LA content was in sample 10 (1.23%), which was due to the extremely high dry matter content. The same results were achieved by Loučka *et al.* (2017), who found a lactic acid content of 1.13% in alfalfa silage with a dry matter content of 56.3%. Similarly, Wang *et al.* (2019) described that LAB activity is significantly weakened in silages with a high dry matter content. The average acetic acid content (0.66 ± 0.17%) corresponds to the homofermentative type of fermentation and the optimal range, which is in line with the findings of Ding *et al.* (2011). According to Kung *et al.* (2018), the propionic acid content in quality silages should be < 0.1%. The tested operational silages reached only trace amounts (0.02 ± 0.01%), which is in line with the findings of Gua *et al.* (2019) and Penga *et al.* (2024). Butyric and valeric acids were not detected in any of the samples. Ding *et al.* (2011) also achieved the same results. The sum of acids in the dry matter was on average 7.40 ± 2.80%. The high value in samples 5, 8 and 9 indicates quality fermentation, while silage 10 again affected the overall average with a low value (2.48%). The consequence of the high dry matter content in this sample was a strongly reduced fermentation. The degree of proteolysis (6.3%) indicates a low degree of CP degradability. A positive correlation was confirmed between the degree of proteolysis and CP degradability (r = 0.901), with the degree of proteolysis increasing with increasing CP degradability.

The nutritional value of the operational alfalfa silages is documented in Table 2. The results shown in the table show that the average crude protein content was within the acceptable range for alfalfa silages (198.9 ± 8.7 g/kg DM). Kung *et al.* (2018) report that alfalfa silage harvested at the budding stage has around 20% crude protein. Similar crude protein results were also achieved by Wang *et al.* (2020) and Ding *et al.* (2011). The average protein degradability is at a medium level (74.73±1.78%), as 75-90% of alfalfa CP is microbially degraded in the rumen. The content of crude fibre (282.5 ± 17.4%) and ADF fractions (328.6 ± 13.2 g/kg DM) and NDF (358.7 ± 10.4 g/kg DM) correspond more to the values of the harvest at the beginning of flowering. Similar results are also reported by Guo *et al.* (2019). The degradability of crude fibre of alfalfa silages in the rumen is at the level of 21.61 ± 4.07%. A higher level is usually analysed in the first cuts due to a lower degree of lignification of the tissues. The average dry matter digestibility (65.24 ± 1.53%) corresponds to the relatively low content of fibre fractions. In the set of evaluated silages, it was confirmed that silages with a lower ADF content had higher dry matter digestibility. The calculated negative correlation (r = −0.886) between ADF content and digestibility shows that each 1% decrease in ADF content increases dry matter digestibility by approximately 0.5–1%. The average energy concentration of NEL (4.30 ± 0.04 MJ/kg DM) corresponds to the energy content commonly achieved in protein silages. The energy content is always related to the level of digestibility of organic matter and the crude fibre content, or the harvest stage of the forage.

The results showed certain differences in resistance to aerobic spoilage, both in the time of onset of degradation itself and in the maximum temperature reached. From the course of the curves (Fig. 1), it can be stated that all tested silage samples did not show aerobic instability, as they exceeded the temperature limit of 23 °C between the 125th and 135th hour of aeration. The heating of the silage was apparently caused by mould activity and occurred in all samples more or less simultaneously, with the maximum between the 140th and 150th hour. The highest increase in pH was recorded in the silage with the highest dry matter content (639.9 g/kg). Indicating a more pronounced destabilisation of the silage after opening. This change in pH may be due to the intensive activity of lactate-assimilating yeasts and bacteria that metabolise the formed lactic acid, leading to deacidification and loss of stability (Pahlow *et al.*, 2003). A stable or decreasing pH value indicates fermentation equilibrium, while an increase in pH indicates an undesirable microbial process.

Despite the low ethanol finding (0.05%), according to Muck *et al.* (2018), latent yeast activity cannot be completely interpreted. The results of testing the aerobic stability of the evaluated silages indicate that the application of the combined silage preparation used led not only to an improvement in the fermentation process but also to an increase in the aerobic stability of the silages. This trend is in line with the results of the studies by Saarisalo *et al.* (2006) and Jaakkola *et al.* (2010), who confirmed that the combination of Lactobacillus plantarum with sodium benzoate was more effective in enhancing aerobic stability than the microbial combination of *Lactobacillus plantarum* and *Lactobacillus buchneri* alone.

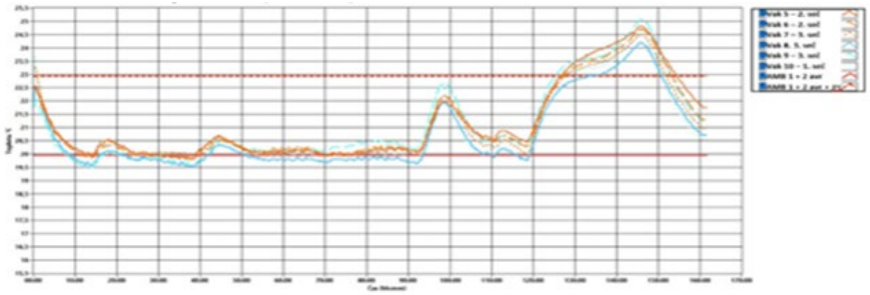

Fig. 1: Aerobic stability of packed lucerne silages

CONCLUSION

This study evaluated the effect of different dry matter contents during ensiling lucerne using PE bag technology on the final quality and aerobic stability. It is important to note that the dry matter content in some bags showed great variability. A microbial chemical preservative was used during preservation in all studies. With increasing dry matter content, a decrease in the production of fermentable acids, including LA, was found. No butyric acid production was, and the degree of proteolysis was low. DOM was lower than 66%, and the NEL concentration was also low (4.30 MJ/kg DM). Operational alfalfa silages did not show increased susceptibility to aerobic spoilage with high dry matter content. The findings indicate that the addition of the silage additive used limited the development of yeast and fungi and prevented unwanted heating.

REFERENCES BY AUTHORS

Contact Information

Doležal Petr: e-mail: petr.dolezal@mendelu.cz