THE EFFECT OF FEEDING POOR-QUALITY SILAGE ON RUMEN FERMENTATION PROCESSES, METABOLIC PROFILE, AND HEALTH STATUS OF DAIRY COWS

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INTRODUCTION

Nutrition of dairy cows is considered the most important environmental factor determining milk production, fertility, animal health, and enabling the realization of the genetic potential of both individuals and the entire herd.

Silages form the basic component of dairy cow rations. Their quality determines the nutritional value and palatability of the diet and thus the total dry matter intake. High-quality maize silage has a high energy value, is well accepted by animals, and stabilizes fermentation processes in the rumen. In most dairy herds, it forms the basis of total mixed rations (TMR) throughout the year and is an important energy source during early and peak lactation. It influences milk yield and quality, animal health, and fertility. In combination with conserved protein forages and concentrate feeds, it creates optimal conditions for formulating TMRs with a high nutrient concentration required for high-producing dairy cows, while maintaining appropriate dietary effects and minimizing digestive disorders.

High-quality conserved forage is therefore indispensable for high-producing dairy cows. A major advantage of maize silage is that maize starch, compared to wheat and barley starch, is digested more slowly and partially escapes rumen fermentation. Its digestion in the intestine provides a direct source of glucose for dairy cows during early and peak lactation when they are in negative energy balance, thus helping to prevent ketosis.

Silage quality is influenced by many factors throughout all stages of production, storage, and feeding. Conserved forages are often not of the required quality and may pose health risks. Even well-produced silages that meet quality standards can quickly become problematic or hygienically unsuitable feeds. This situation is frequently observed in many herds during spring and summer when secondary aerobic fermentation occurs.

Aerobic fermentation of silage (also referred to as secondary fermentation or spontaneous heating) is caused by yeasts, bacteria, and fungi, with yeasts playing the most significant role. Yeasts are highly acid-tolerant, survive within a wide temperature range (8–35 °C), and persist in silage for long periods. Similarly, mold spores and some bacteria can survive. Under suitable conditions, adequate oxygen, moisture, and temperatures of approximately 12–35 °C, yeasts multiply rapidly and disrupt the preserved feed.

Yeasts intensively metabolize lactic acid and residual soluble sugars, producing heat, carbon dioxide, and water. As a result, the energy value of the silage decreases, and dry matter losses occur. Degradation of lactic acid alters the pH of the silage, creating favourable conditions for the growth of bacteria and fungi. Consequently, products of putrefaction, mycotoxins, and various toxic biogenic amines (such as cadaverine, tyramine, putrescine, spermidine, tryptamine, and histamine) accumulate. The number of bacteria such as *Escherichia coli*, Klebsiella, *Clostridia*, and *Listeria* increases. Heating of the silage mass leads to the formation of indigestible compounds. Such aerobically deteriorated feed has low nutritional value and is hygienically unsuitable, negatively affecting animal health, production, and reproduction.

Aerobically damaged forage reduces the value of the entire TMR. Yeasts rapidly degrade sugars added via molasses or feed sugar, fungi proliferate and produce large amounts of mycotoxins, proteins are degraded, and pathogenic bacteria multiply. These undesirable processes continue until the feed is consumed or removed.

Metabolites formed during aerobic fermentation reduce feed palatability, leading to a significant decrease in dry matter intake. Serious changes also occur in the rumen. Optimal rumen fermentation requires adequate nutrient intake; however, aerobic deterioration reduces soluble carbohydrates and protein digestibility, and ingested bacteria negatively affect rumen microflora and protozoa. Mycotoxins also have a highly detrimental effect on rumen fermentation.

As a result, digestive disorders such as simple indigestion, alkalosis, and putrefaction of rumen contents may develop. Typical clinical signs associated with feeding aerobically deteriorated forage include reduced appetite, decreased milk yield, changes in milk composition and quality, increased incidence of mastitis, diarrhoea, hoof diseases, and a high prevalence of purulent endometritis. The health status of cows is also reflected in the health of newborn calves.

Objective

The aim of this study was to evaluate the effect of feeding spoilt maize silage (secondary aerobic fermentation) on rumen fermentation processes, metabolic profile, and overall health status of dairy cows.

METHODS

At the request of the farmer, dairy cows were examined to determine the cause of a sudden and significant decrease in milk yield and an increase in somatic cell count. Daily milk production decreased by 3.5 L (from 38.2 L to 34.7 L). Somatic cell count in bulk milk increased from 180,000 to 320,000 cells/mL. Reduced feed intake was observed.

Rumen fluid and blood samples were collected from selected cows. Laboratory analyses were performed using standard methods at the Clinical Laboratory for Large Animals. In maize silage, concentrations of mycotoxins DON, T-2 toxin, and zearalenone were determined and found to exceed permissible limits.

As the results listed in Table 1 show, the feeding of spoilt silage negatively affected rumen fermentation processes. Total volatile fatty acid (VFA) concentration was only 62.96 ± 21.31 mmol/L compared to the physiological range of 80–120 mmol/L. The number of protozoa was also significantly reduced, indicating an unfavourable rumen environment. The proportion of individual VFAs was not significantly altered. Lactic acid concentration was below 1 mmol/L.

The blood metabolic profile indicated liver damage. High creatine kinase (CK) activity suggested weight loss and muscle catabolism. Significant changes were also observed in calcium, zinc, and vitamin A levels. Impaired rumen fermentation led to reduced absorption of calcium and zinc, resulting in hypocalcaemia and hypozincaemia. Decreased vitamin A levels were associated with impaired liver function and reduced conversion of beta-carotene.

Feeding spoilt maize silage resulted in reduced TMR intake, impaired rumen fermentation, liver disorders, decreased milk production, weight loss in dairy cows, and an increased incidence of lameness.

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CONCLUSION

Feeding aerobically deteriorated maize silage had a markedly negative impact on rumen fermentation, metabolic status, and overall health of dairy cows. The observed reduction in total volatile fatty acid concentration and protozoal counts indicates impaired rumen functionality, likely driven by decreased nutrient availability and the presence of undesirable microbial metabolites.

Metabolic profiling further revealed signs of hepatic impairment and mineral imbalance, particularly hypocalcaemia and hypozincaemia, together with reduced vitamin A status, suggesting compromised nutrient absorption and altered metabolic homeostasis.

These disturbances were associated with reduced feed intake, decreased milk yield, increased somatic cell count, and clinical signs including weight loss and lameness.

Overall, the findings highlight that even short-term feeding of poor-quality silage can substantially disrupt rumen ecology and systemic metabolism, leading to significant production losses and health deterioration in dairy cows. Ensuring high silage quality and preventing aerobic spoilage is therefore critical for maintaining performance and animal health in dairy systems.

Tab. 1: Metabolic profile

Serum	Unit	Mean	SD
Total protein	g/L	72,94	2,55
Albumin	g/L	34,44	3,46
Bilirubin	μmol/L	4,78	2,71
BHB	mmol/L	0,83	0,23
NEFA	mmol/L	1,05	0,23
AST	μkat/L	2,62	0,87
GGT	μkat/L	0,52	0,21
CK	μkat/L	18,8	13,3
Na	mmol/L	145,64	3
K	mmol/L	4,67	0,91
Ca	mmol/L	2,1	0,14
P	mmol/L	1,43	0,36
Mg	mmol/L	1	0,12
Zn	μmol/L	6,63	2,66
Cu	μmol/L	15,38	0,93
Vitamin A	μmol/L	0,73	0,5
Vitamin E	μmol/L	7,96	1,95
Beta-carotene	μmol/L	5,86	1,67
Rumen fluid			
Rumen pH		6,78	0,36
Total VFA	mmol/L	62,96	21,31
Acetic acid	mol%	63,82	1,12
Propionic acid	mol%	19,74	1,78
Butyric acid	mol%	12,96	1,93
Valeric acid	mol%	3,74	0,62
Protozoa	thous./mL	163,2	73,43
Ammonia	mmol/L	6,76	4,99

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