EFFECTS OF *ARTEMISIA ARGYI* ACTIVE MATTER ON THE AEROBIC STABILITY OF WHOLE-CROP CORN SILAGE

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Abstract

In this study, whole-crop corn was fermented by adding eudesmol, essential oil, flavanone, and their mixture (group M) extracted from *Artemisia argyi* (AA), with a blank group and a group treated with *Lentilactobacillus buchneri* (LB) serving as controls. After 90 days (d) of ensiling, samples were exposed to oxygen for 0, 1, 3, 5, and 7 d to analyze changes in fermentation quality, chemical composition, and microbial populations. The results indicated that after 90 d of ensiling, group M exhibited the lowest pH value (4.63), the highest contents of acetic acid (82.61 g/kg DM) and water-soluble carbohydrates (WSC, 26.44 g/kg DM). During the aerobic exposure period, group A had a significantly lower pH value than the control group (CK), while groups J, H, and M had higher WSC content than the CK. Group M, in particular, had the highest dry matter, crude protein and WSC content, the lowest ammonia nitrogen content, and a relatively lower abundance of harmful microorganisms. In summary, the addition of AA active components effectively suppressed microbial metabolism and improved the fermentation quality of silage, providing a theoretical basis for the development of new feed supplements and the enhanced utilization of traditional Chinese herbal medicine resources.

Keywords: whole-crop corn, *Artemisia argyi*, active components, silage, aerobic exposure

INTRODUCTION

Whole-crop corn (WCC) silage, with its high nutritional value and excellent palatability, is the predominant roughage source for dairy cows and other ruminants (Pang *et al*., 2024). Silage is prone to aerobic microbial activity, causing pH rise and spoilage (Pang *et al*., 2011, Pang *et al*., 2023). Therefore, how to inhibit the proliferation of aerobic microorganisms and improve the quality of silage during ensiling has become a research focus in recent years. In this study, active components of *Artemisia argyi* (AA) were added to WCC at the milky stage for 90 days (d) of mixed ensiling, followed by aerobic exposure. By comparing the fermentation quality, chemical composition, and microbial communities of WCC supplemented with different active components of AA, this study aims to elucidate the effects of AA active components on silage quality during ensiling and aerobic exposure, thereby providing a theoretical basis for the development of novel feed additives.

MATERIAL AND METHODS

Whole-crop corn (WCC) at the milky stage (Xingyang, Henan Province); whole-plant AA (Anyang, Henan Province); LB provided by China Agricultural University; AA essential oil (purity: 990 g/kg) and crude flavonoids (purity: 150 g/kg) were purchased from Shaanxi Taihe Kangze Biotechnology Co., Ltd.; eucalyptol (purity: 990 g/kg) was purchased from Shanghai Macklin Biochemical Technology Co., Ltd.

The experimental design was as follows: based on the additive type, the treatment groups were designated as A, J, H, M, and LB, which received eucalyptol, essential oil, flavonoids, and a mixture of these three components derived from AA, respectively, at a rate of 600 g/kg of WCC. WCC (CK) and LB (6.00 lg cfu/g) were set as control groups. The moisture content was adjusted to 650 g/kg fresh matter. The mixture (300 g) was placed into fermentation bags and vacuum-sealed. Each group had 3 replicates and was fermented for 90 d, followed by aerobic exposure at room temperature (16-35 °C) for 0, 1, 3, 5, and 7 d. At each opening, the fermentation quality, chemical composition, and microbial communities were analyzed.

RESULTS AND DISCUSSION

After 90 d of ensiling, group M exhibited the lowest pH value, along with the highest lactic acid and water-soluble carbohydrate (WSC) contents, reaching 4.63, 82.61 g/kg DM, and 26.44 g/kg DM (dry matter), respectively. In contrast, group LB showed the lowest ammonia nitrogen and acetic acid contents, at 0.13 g/kg DM and 28.11 g/kg DM, respectively. With With prolonged aerobic exposure, the pH value of each treatment group increased significantly, while the concentrations of WSC, lactic acid and acetic acid decreased significantly. After 7 d of aerobic exposure, group A had the lowest pH value and the highest lactic acid and acetic acid contents, whereas group M had the highest WSC content and the lowest ammonia nitrogen content.

For chemical composition, after 90 d of ensiling, Group M had the highest dry matter (DM) and crude protein (CP) contents, reaching 409.0 g/kg and 74.88 g/kg DM, respectively, while the contents of acid detergent fiber (ADF) and neutral detergent fiber (NDF) were the lowest, at 298.00 g/kg DM and 436.33 g/kg DM, respectively. As aerobic exposure time increases, DM content in all treatment groups continued to rise, ADF and NDF contents gradually decreased, while CP content exhibited dynamic changes. After 7 d of aerobic exposure, group J achieved the highest DM content, group M had the lowest ADF and NDF contents, and group H showed the highest CP content.

In this study, the Chao1 index and Shannon index were used as key diversity indicators to evaluate the species richness and diversity of microbial communities under different treatment conditions. For bacterial communities, the Shannon index of the H-90 group was significantly higher than that of the other groups, indicating that this group had the highest bacterial community diversity. After 3 days of aerobic exposure, the A-90-3d group showed the lowest Shannon index, suggesting that different treatments had a significant impact on bacterial diversity. For fungal communities, Shannon index analysis showed that the fungal community diversity was highest in the WCC group and lowest in the J-90 group, with extremely significant differences among treatments

At the bacterial phylum level, after 90 d of ensiling, the dominant phylum in all treatment groups was Firmicutes. After 3 d of aerobic exposure, the relative abundance of Firmicutes decreased in all treatment groups except the M-90 group, where it increased. This may be attributed to the inhibition of Firmicutes bacteria, such as lactic acid bacteria, during aerobic exposure, along with the proliferation of aerobic microorganisms and the rise in pH, which is unfavorable for the growth of Firmicutes. At the genus level, for bacteria (Figure 2a), after 90 d of ensiling, the dominant genus in the A-90, H-90, and M-90

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groups was *Lactiplantibacillus*. After 3 d of aerobic exposure, the A-90-3, J-90-3, and M-90-3 groups remained dominated by *Lactiplantibacillus*, with relative abundances of 0.2573, 0.1869, and 0.2973, respectively. At the fungal phylum level, after 90 d of ensiling and 3 d of aerobic exposure, the fungal communities in all treatment groups were dominated by Ascomycota, with no significant differences observed. At the fungal genus level (Figure 2b), *Candida* was predominant in the H-90 and M-90 groups, while varying proportions of *Candida* were detected in the other treatment groups.

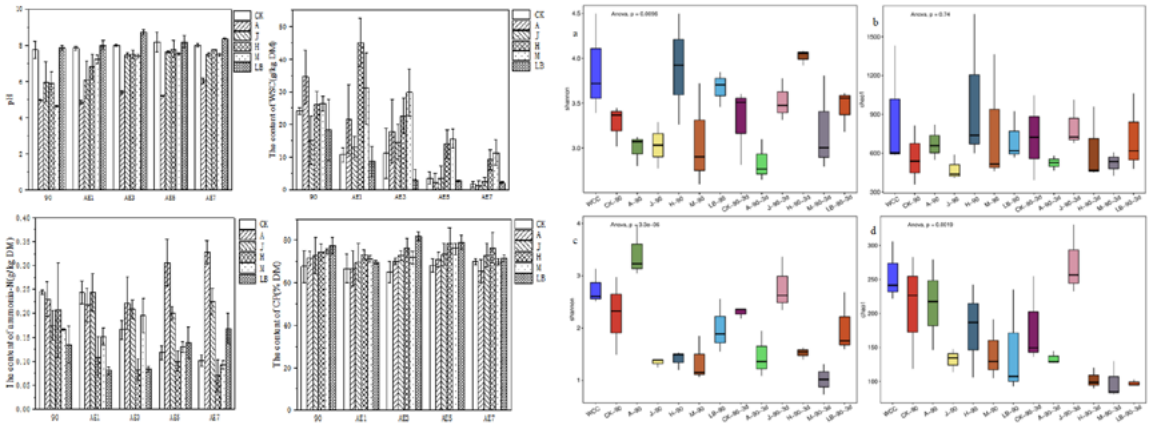

Fig. 1: Fermentation quality and chemical composition of silage, and Alpha diversity at the OTU level (a, b and c, d: Shannon, Chao1 index of bacterial and fungal community, respectively)

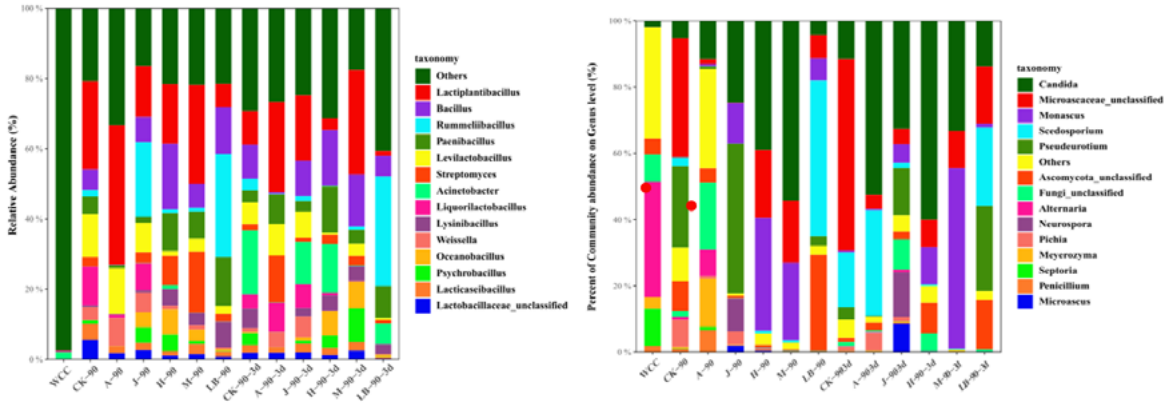

Fig. 2: Bacterial (a) and fungal (b) community composition of WCC at the genus levels

CONCLUSION

In this study, WCC at the milky stage was ensiled with the addition of active components derived from AA (eucalyptol, essential oil, and crude flavonoids). After 90 d of ensiling, group M exhibited the lowest pH value, along with the highest lactic acid, WSC contents, DM and CP contents. As the duration of aerobic exposure increased, the treatment groups supplemented with AA active components demonstrated better stability, characterized by a slower increase in pH and reduced losses of WSC and organic acids. This indicates that the addition of AA active components can effectively delay aerobic spoilage and maintain silage quality. In summary, the addition of AA active components significantly improves the fermentation quality and aerobic stability of WCC silage, inhibits the growth of harmful microorganisms, reduces nutrient loss, and thereby enhances the preservation capability and feeding value of the silage.

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