Effect of *Lactobacillus plantarum* on Fermentation Quality of Alfalfa Silages Mixed with Different Proportions of Jujube Powder

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Introduction

Hebei province is one of the main production areas of alfalfa (*Medicago sativa*) in China. While alfalfa is used to make silages, it is necessary to improve the fermentation quality of alfalfa silage. Jujube powder which contains a high content of sugar, might be a good material to ensile mixed with alfalfa. On the other hand, the effect of lactic acid bacteria (LAB) has been documented and has been used as an additive to achieve good preservation of silage.

The objective of this study was a) to screen different ratios of jujube powder in the mixed silage of alfalfa and jujube powder and b) verify the effect of *Lactobacillus plantarum* strain on fermentation quality of the alfalfa silages.

Methods

Alfalfa was harvested at fourth crop in budding stage at Huanghua, Hebei Province, China. The jujube powder used in silage mixtures was made from golden silk jujube. The *Lactobacillus plantarum* strain (LP) used in the experiment was extracted from epiphytic LAB population from alfalfa silages without any additive in Huanghua and added to silage at 1x 106 CFU/g. Six mixture rates of alfalfa (A) and jujube powder (J) were designed in this experiment: alfalfa (100A0J), 97:3 (97A3J), 94:6 (94A6J), 91:9 (91A9J), 88:12 (88A12J) and 85:15 (85A15J). Each treatment of mixed silage was separated in two groups, one was treated with the *L. plantarum* (LP) and the other was treated without LP. All treatments were used to make silages and the fermentation quality was determined after 60 days of ensiling at a temperature of 30°C. Dry matter (DM), pH value, lactic acid (LA), acetic acid (AA) and ammonia nitrogen for total nitrogen (NH_3-N/TN) were determined in this experiment according to the method of Bai *et al.* (2011).

Results and discussion

The fermentation quality of the silages are described in Figure 1. Regardless of the level of treatment, all silages in this experiment were well-preserved. PA and BA contents of most silages were not detected.

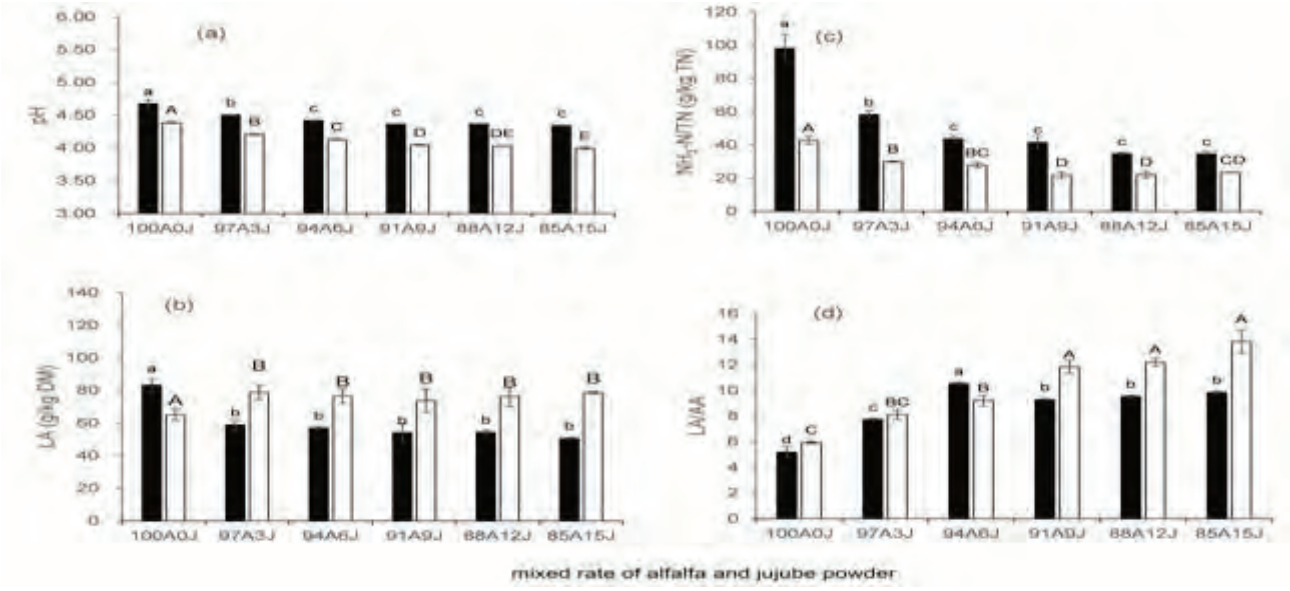

Figure 1. Fermentation quality of the alfalfa silages mixed with jujube powder and treated with *Lactobacillus plantarum*. LA, lactic acid; AA, acetic acid; LA/AA, lactic acid/acetic acid; NH_3-N/TN, Ammonia Nitrogen in total nitrogen; A, Alfalfa; J, jujube powder; Black columns, silages treated without LP; Open columns, silages treated with LP. Standard error of mean built on the basis of three replications. Means with different upper or lower case letters differ ($P < 0.05$).

For the alfalfa silages untreated with LP, adding jujube powder can produce a significant (P<0.05) decrease in pH value. From treatment 94A6J, pH value decreased to the minimum and remained stable (Fig. 1a). Silages treated with LP had lower (P<0.05) pH values than the untreated silages. For the mixture rate of alfalfa and jujube powder of 85:15, the pH value could reach 3.95. The decline rate of pH is a key factor in inhibiting *Clostridium spp*. and reducing fermentation losses (Carpintero *et al.* 1979). Good silage fermentation requires pH<4.2. It is possible that the addition of jujube powder provided plenty of water soluble carbohydrate (WSC) which could promote the activity of epiphytic LAB. On the other hand, addition of LP inoculant could increase the amount of lactic acid bacteria.

The key factors determining the pH value were LA and AA contents. For silages mixed with alfalfa and jujube powder and treated with LP, LA contents were higher (P<0.05) than the untreated silages (Fig. 1b). *L. plantarum* used in this experiment was homofermentation lactic acid bacteria, which could produce lactic acid and promote the fermentation quality of silages. Ratio of LA/AA was the way to judge fermentation type of silages and could be increased by mixed ratio of jujube powder and LP (Fig. 1d). Homofermentation played a dominant role in alfalfa silages and as the mixture ratio of jujube powder increased or with the addition of LP inoculate, homofermentation was promoted.

The proportion of NH_3-N/TN not only reflects the degree of proteolysis in the fermentation process but is also an important factor affecting the silage N-use efficiency in the rumen (Thomas *et al.* 1980). Compared to the control silages, *L. plantarum* could significantly decreased NH_3-N/TN content and the ratio of jujube also had positive effects on decrease of NH_3-N/TN content (Fig. 1c).

There were interactions (P<0.05) in NH_3-N/TN, LA contents and ratio of LA/AA between LP inoculation and mixture rate of jujube powder. Silages mixed with 91% alfalfa and 9%jujube powder and treated with LP inoculant appear be the proportion to achieve the best fermentation quality.

Conclusion

All silages in this experiment were well preserved and had good fermentation quality. Addition of jujube powder and *Lactobacillus plantarum* can enhance the fermentation quality of alfalfa silages. The appropriate ratio of alfalfa and jujube powder is 91:9 combining with addition of LP.

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