The effect on long-chain fatty acids in lucerne silage with jujube powder and *Lactobacillus plantarum*

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Introduction

The major nutrients of lucerne silage are well documented. However, forages are also an important dietary source of α-linolenic acid (C18:3n-3) and linoleicacid (C18:2n-6) that are biohydrogenated in the rumen, originating a complex pattern of C18 fatty acids (Jenkins *et al*. 2008). Studies have reported slight effects on the fatty acid (FA) composition of grass silages by the use of additives like formalin, formic acid, or enzymes (Alves *et al*. 2011) However, there are no studies on the addition of jujube powder in lucerne silage, which has a high sugar content. The effect of *Lactobacillus plantarum* (LA) on the silage fermentation quality has been frequently observed. Few studies have focussed on long-chain fatty acids in lucerne silage with jujube powder and *Lactobacillus plantarum.*

The objective of this study was to evaluate the effect of the addition of jujube powder and the *Lacto-bacillus plantarum* on the long-chain fatty acids (mainly C16-C18) in lucerne silage.

Materials and methods

Lucerne in squaring stage (at the beginning of flowering) was harvested from a lucerne field in October 2012 at Huanghua, Hebei Province, China. The materials were chopped to a theoretical particle size of 1–2 cm and were assigned to the following treatments:
(1) Untreated (Control), 100% lucerne without LP);
(2) UNLP (100% lucerne with LP);
(3) 3%JP (contains 3% jujube powder without LP);
(4) 3%JPLP (contains3% jujube powder with LP);
(5) 6%JP (contains 6% jujube powder without LP);
(6) 6%JPLP (contains 6% jujube powder with LP);
(7) 9%JP (contains 9% jujube powder without LP);
(8) 9% JPLP (contains 9% jujube powder with LP);
(9) 12% JP (contains 12% jujube powder without LP);
(10) 12%JPLP (contains 12% jujube powder with LP);
(11) 15%JP (contains 15% jujube powder without LP);
(12) 15% JPLP (contains 15% jujube powder with LP).

LP is the *Lactobacillus plantarum*, which was isolated from lucerne silage and was added to silage at 1×10^6CFU/g in this experiment. All forages were ensiled in plastic bags with 200-300 g fresh material in each bag for 60 days in 30°C by using a constant temperature incubator, with triplicate silos for each treatment. The method to extract the long-chain fatty acids from silage was described by Pritam *et al.* (1988). The proportions of the six FA: C16:0, C16:1, C18:0, C18:1n9c, C18:2n6c and C18:3n3 were calculated against the sum of these six FA.

Results and Discussion

The content of C18:1 was highest in the lucerne silage treated with 3% jujube powder (Table 1). The content of C18:2 in the lucerne silage with 6% jujube powder was higher than in other treatments. The content of C16:1 was highest in the Lucerne silage treated with 15% jujube

Table1. The long-chain fatty acid content (mg/gDM) of Lucerne silage with different jujube treatments. Within a column means without a common letter differ (P<0.05).

Treatment	C16:0	C16:1	C18:0	C18:1n9c	C18:2n6c	C18:3n3
Control	0.05873 ab	0.00426 a	0.03401 ab	0.004 b	15.374 ab	0.03579 bc
UNLP	0.03193 b	0.000959 a	0.02791 ab	0.002 b	4.530 b	0.03579 bc
3%JP	0.08245 ab	0.007436 a	0.03865 ab	9.016 a	15.844 ab	0.03906 b
3%JPLP	0.00647 b	0.000496 a	0.00439 b	0.000 b	1.094 b	0.00026 c
6%JP	0.07864 ab	0.003819 a	0.04298 ab	0.002 b	22.457 a	0.07681 a
6%JPLP	0.01325 b	0.000483 a	0.00643 b	0.000 b	1.381 b	0.00148 c
9%JP	0.05645 ab	0.003417 a	0.01344 b	0.005 b	7.594 ab	0.00544 bc
9%JPLP	0.01424 b	0.00152 a	0.08415 ab	0.012 b	1.584 b	0.00065 c
12%JP	0.07334 ab	0.003894 a	0.0071 b	0.005 b	15.759 ab	0.02169 bc
12JPLP	0.0099 b	0.000259 a	0.0071 b	0.004 b	2.853 b	0.00254 bc
15%JP	0.15358 a	0.027271 b	0.16386 a	0.065 b	1.584 b	0.02886 bc
15%JPLP	0.00647 b	0.000787 a	0.02023 b	0.001 b	2.853 b	0.00060 c

powder. To varying extents, the presence of jujube powder enhanced the nutrition of lucerne silage by sustaining or even increasing the content of one or more kinds of long-chain fatty acids.

Previous work, such as Alves.*et al.* (2011), observed a decrease in proportions of FA in ryegrass silage with Lactic acid bacteria .Our results corroborate this finding, with the addition of LP decreasing the content of the long-chain fatty acids in the silage. Lactic acid bacteria commonly found in forages have the ability to biohydrogenate C18:2 and C18:3 (Ogawa *et al*. 2005). Moreover, some lactic acid bacteria have been described as intermediates in the biohydrogenation of 18:3 by rumen bacteria. Although the rumen biohydrogenation has been extensively studied, its role in ruminal microbial ecology is not completely understood (Jenkins *et al*. 2008). It is essential to identify the related bacteria for biohydrogenation in silage and it could be useful to study the mechanism of FA changes. Most of the studies on the FA composition of silages have been concerned with losses of C18:2 and C18:3, given that increased content of both C18:2 and C18:3 in animal diets might increase their transfer to milk or meat of ruminants and, consequently, increase their concentration in the human diet. Therefore, more study should be focussed on long-chain fatty acids of lactic acid bacteria in silage including minor and unusual FA.

Conclusions

The content of C18:1 was highest in the lucerne silage treated with 3% jujube powder. The content of C18:2 in the lucerne silage with 6% jujube powder was higher than in other treatments. The content of C16:1 was highest in the lucerne silage treated with 15% jujube powder. To varying extents, the presence of jujube powder enhanced the nutrition of lucerne silage by sustaining or even increasing the content of one or more kinds of long-chain fatty acids.

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