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Mechanism Research of Fermented Tomato Pomace and Its Effect on Oxidation Resistance of Transition Dairy Cows

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Abstract This study was carried out to evaluate the effects of replacing corn silage with ensiled tomato pomace on dry matter intake and apparent digestibility of diets. Eight close up dry Holstein cows were used in 2×2 Latin square design. The animals were fed control (0% tomato pomace silage) and experimental (10% corn silage replaced by tomato pomace silage) diets. The result showed that dry matter intake in experimental group was 9.77 ± 0.44 kg/d, which was significantly higher than in control group ($p < 0.05$). Dry matter digestibility in experimental and control group was 73.9% and 70.2%, respectively, but there was no difference between two groups ($p > 0.05$). The substitution of tomato pomace silage in diet was associated with an increase of dry matter intake, dietary supplement of ensiled tomato pomace without any adverse effect on their health performance.

Key words Tomato pomace, Total mixed ration, Dairy cows, Dry matter intake, Digestibility

1 Introduction

Xinjiang is the largest processing tomato production area in China, and the canning industry generates (or discharges) up to 600000 tons of tomato pomace a year^[1]. Tomato pomace consists of the skins, seeds, unripe tomatoes and small quantity of pulps, and contains 20–25% crude protein (CP), 57–67% neutral detergent fiber (NDF). In addition, it contains more essential amino acids compared to alfalfa meal of good quality^[2]. If tomato pomace is unused, it will cause serious environmental pollution and act as a substrate for insect and microbial proliferation^[3]. Tomato pomace has storage problems because of the high moisture about 80%. So, it can be fed to ruminant animals for long periods of time without spoilage, when it is ensiled with or without additives^[4,5]. Studies have shown that tomato pomace silage with straw can be good quality roughage for sheep. The feeding of ruminants on dried or silage tomato pomace has been studied to dairy cows and sheep^[6,7] to evaluate ruminal fermentation, blood metabolites, chewing activity, growth, and diet digestibility^[8–9]. Considering that the use of tomato processing by-products could provide extra income and at the same time reduce the waste disposal problem, the objective of present study was to evaluate the effects of 10% corn silage replaced by tomato pomace silage in diets of dairy cows during the close-up calving period on dry matter intake (DMI), nutrient total tract digestion.

2 Materials and methods

2.1 Tomato pomace silage preparation Fresh experimental samples of tomato pomace were collected from factory in Changji, Xinjiang, China (Tunhe Zhongliang Tomato Products Co., Ltd).

Tomato pomace ensiled with lactic acid bacteria in a stretch silo on a concrete floor. The tomato silage was sealed for one month, and then fed as TMR diets.

2.2 Animal and feeding procedures Animal measurement was conducted in Tianshan Animal Husbandry Bio-engineering Co., Ltd., Changji, Xinjiang, China. Eight dry Holstein dairy cows from close up period were used in 2 × 2 Latin square design. It was fed with the diet of control group (0% tomato pomace silage) and experimental group (10% corn silage replaced by tomato pomace silage). The total mixed rations (TMR) are given in Table 1. Each experimental period lasted 18 days, adaption 14 days and sample collection 4 days. The animals were kept in individual concrete tie-stalls and had free access to drinking water at all times. The daily TMR diets were given in two equal feeds at 09:00 and 17:00 to provide approximately 10% feed refusal each day as fed basis. Feed refusals were removed and weighed before feed was offered at 08:00. (i) Dry matter intake trial. Dry matter intake was calculated as the difference between DM offered and refused. Samples of both diets were collected daily and composition samples were analyzed for dry matter (DM), crude protein (CP) by chemistry following AOAC^[10] procedure and for NDF following the method of Goering and Van Soest^[11]. (ii) Digestibility trial. Diets and fecal samples were applied at which Acid Insoluble Ash (AIA) used a modification of the 3N HCL procedure described by Van Keulen and Young^[11]. Fecal samples were collected once per day during the last 4 d of feeding period and samples of diets were collected for 3 d before initiation of fecal collection. Fecal and diet samples were dried in a forced – air oven at 60°C and ground to pass through a 1 – mm sieve. Composition samples of diets and fecal were analyzed by the above methods. Digestibility values were obtained as follows:

$$\text{AIA dry matter digestibility} = 100 - \left[100 \times \left(\frac{\% \text{ marker in diet}}{\% \text{ marker in feces}} \right) \right];$$

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$$\text{AIA dry matter digestibility} = 100 - \left[100 \times \left(\frac{\% \text{ marker in diet}}{\% \text{ marker in feces}} \right) \times \left(\frac{\% \text{ nutrient in feces}}{\% \text{ nutrient in diet}} \right) \right].$$

3 Data analysis

The data were statistically analyzed using the *t*-test of Excel. Level of significance was 0.05, and the *t*-test was used to compare differences between treatments.

4 Results

Table 2 showed that average DMI value was 9.77 ± 0.44 kg/d in experimental group and significantly higher than in control group (*p* < 0.05). Intake rate of cows in experimental group was significantly higher than in control group. Dry matter digestibility of cows in experimental group was 73.95 ± 3.46%, slightly higher than in control group, but there was no significant difference between the groups. Table 3 showed that CP excretion of cows in ex-

perimental group was increased, but there was no significant difference of CP digestibility between the groups. The NDF excretion and NDF digestibility of the cows fed tomato pomace silage had no significant differences (*p* > 0.05).

Table 1 Ingredient and composition of experimental TMR (%DM)

Items	Control group	Experimental group
Ingredients//%		
Corn silage	53.00	40.00
Tomato pomace silage	—	13.00
Wheat straw	17.00	17.00
Concentrated feed	30.00	30.00
Total	100.00	100.00
Chemical composition//%		
Crude protein	10.81	10.36
Neutral detergent fiber	42.66	43.00
Calcium	0.58	0.66
Phosphorus	0.30	0.31

Table 2 The effects of dietary tomato pomace on feed intake and digestibility of dairy cows

Items	Control group	Experimental group	<i>p</i> value
Feed intake, kg dry matter day ⁻¹	9.15 ± 0.42	9.77 ± 0.44	*
Intake rate//%	86.68 ± 3.81	91.05 ± 2.46	*
Feces amount//kg	2.71 ± 0.43	2.55 ± 0.35	NS
Dry matter digestibility//%	70.24 ± 5.25	73.95 ± 3.46	NS

Note: * = *p* < 0.05; NS = not significant.

Table 3 The effects of dietary tomato pomace on excretion and digestibility of dairy cows

Items	Control group	Experimental group	<i>p</i> value
CP intake and digestibility			
CP intake	0.98 ± 0.19	1.12 ± 0.29	NS
Fecal excretion	0.10 ± 0.30	0.12 ± 0.30	NS
CP digestibility	87.76 ± 2.07	89.28 ± 0.98	NS
NDF intake and digestibility			
NDF intake	3.90 ± 1.66	4.20 ± 0.68	NS
Fecal excretion	1.48 ± 0.33	1.46 ± 2.05	NS
NDF digestibility	62.05 ± 6.61	65.24 ± 4.73	NS

Note: NS = not significant.

5 Conclusions and discussions

Results obtained indicated that tomato pomace silage as a potential additional feed resource had a positive effect on dry matter intake and intake rate. Dry matter digestibility and nutrient digestibility did not show the differences. It can be concluded that tomato pomace silage at 10% of the DM of the TMR for dairy cows, did not have a negative effect on dry matter intake and digestibility. Dry matter intake regulated numerous factors including nutritional factor reflecting physical and chemical characteristics of diets^[12]. CP, NDF content is the chemical predictor of DMI by ruminant. The CP content of diets is often related positively to DMI of lactating dairy cows^[13, 15]. This is partly from increased rumen degradation protein effects on digestibility of feed. Mertens^[13] reported that dietary NDF is an indicator of upper and lower boundary of DMI. In addition, tomato pomace has the potential to be a good source of proteins. Our studies result showed that the cows fed the TMR with tomato pomace silage significantly increased (*p* < 0.05) DMI and intake rate during close-up dry period. These results were

in agreement with those obtained by Abdollahzadeh^[8] *et al.* who observed that DMI was significantly increased when lactating cows were fed diets containing ensiled mixed tomato and apple pomace at level of 15 or 30% compared to control. The increase in DMI could be explained partly due to the high palatability of tomato pomace. Digestibility of DM, CP, and NDF was not affected by the amount of tomato pomace in the diet. But, it tended to be higher than in the control group. Although DMI and NDF digestibility was positively related, diminishing returns for increased DMI probably led to increases in NDF digestibility.

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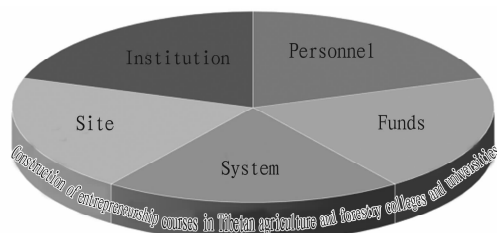


Fig. 1 Five-in-One model for the construction of entrepreneurship courses

7.5 Building the Five-in-One model for construction of entrepreneurship courses in Tibetan agriculture and forestry colleges and universities

To ensure tremendous development of the construction of entrepreneurship courses in Tibetan agriculture and forestry colleges and universities, we should build the Five-in-One model (as shown in Fig. 1), integrating special institution, specialized personnel, special site, special funds, and special system. In other words, it is required to establish a long-term mechanism for entrepreneurship courses in Tibetan agriculture and forestry colleges and universities. Then, it is able to set up the guidance, service and exchange platform for the enterprise education, and do warm-up for autonomous undertaking of students of Tibetan agriculture and forestry colleges and universities. Finally, it is expected to further effectively cultivate and improve the innovation awareness, enterprising spirit, and creativity of students of Tibetan agriculture and forestry colleges and universities, and realize the construction of long-term mechanism for entrepreneurship courses of Tibetan agriculture and forestry colleges and universities.

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