 DOI: 10.19601/j.cnki.issn1943 - 9903.2017.08.021

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 trail. 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℃ 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:

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

Received: June 11, 2017 Accepted: August 18, 2017
Supported by National Natural Science Foundation of China(31472125).
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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 experimental 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	*p* 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	*p* 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.

References

[1] XSY, Xinjiang statistical yearbook [M]. Beijing: Xinjiang Statistical Publishing House, 2011.

[2] AHMED SS, EL-GENDY KM, IBRAHIM H, *et al.* Growth performance, digestibility, carcass trains and some physiological aspects of growing rabbits fed tomato pomace as substitution for alfalfa meal [J]. Egyptian Journal of Rabbit Science, 1994, 4:1 – 18.

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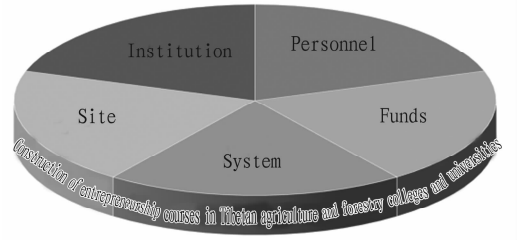

Fig. 1 Five-in-One model for the construction of entrepreneurship courses

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.

References

[1] Ministry of Education of the People's Republic of China. Education for the 21st century revitalizationaction plan[EB/OL]. 1998 - 12 - 24. China Employment Net. http://old. moe. gov. cn/publicfiles/business/htmlfiles/moe/s6986/200407/2487. html. (in Chinese).

[2] Ministry of Education of the People's Republic of China. The Ministry of Education's opinions on promoting the innovation and entrepreneurship of education and college students' self-employment([2010]3)[EB/OL]. 2010 - 05 - 13. China Employment Net. http://old. moe. gov. cn//publicfiles/business/htmlfiles/moe/info _ list/201105/xxgk _ 120174. html. (in Chinese).

[3] HU JT. To unswervingly follow the path of socialism with Chinese characteristics and to strive to build a moderately prosperous society in all respects [EB/OL]. 2012 - 11 - 08. China Communist News Network. http://cpc. people. com. cn/n/2012/1118/c64094 - 19612151. html. (in Chinese).

[4] Ministry of Education of the People's Republic of China. Notice of the General Office of the Ministry of Education on the basic requirements (trial) of the teaching of entrepreneurship education in ordinary undergraduate schools ([2012]4)[EB/OL]. 2012 - 08 - 01. China Employment Net. http://old. moe. gov. cn//publicfiles/business/htmlfiles/moe/s5672/201208/140455. html. (in Chinese).

[5] General Office of the Communist Youth League. The General Office of the Communist Youth League has issued a notice on the implementation of the implementation opinions on the promotion of college students' entrepreneurship by the Communist Youth League([2015]2)[EB/OL]. 2015 - 01 - 07. China Youth Net. http://qnzz. youth. cn/gzdt/201501/t20150113_6403884. htm. (in Chinese).

[6] Ministry of Education of the People's Republic of China. Ministry of Education gives the notification on further completing college graduates' employment and entrepreneurship([2016]5)[EB/OL]. 2016 - 05 - 27. The Ministry of Education of the People's Republic of China. http://www. moe. edu. cn/srcsite/A15/s3265/201606/t20160606_248333. html. (in Chinese).

[7] Office of the People's Government of the Tibet Autonomous Region. The People's Government of the Tibet Autonomous Region transponds the notification on further completing college graduates' employment and entrepreneurship([2009]27)[EB/OL]. 2009 - 04 - 01. China Employment Net. http://www. chinajob. gov. cn/zb/gxbysjyfg/content/2012 - 04/09/content_704472. htm. (in Chinese).

[8] Office of the Communist Youth League of Tibet Autonomous Region. The notification on printing and distributing the suggestions of the implementation of actively promoting university students' innovative undertaking ([2015]23)[Z]. 2015 - 06 - 02. (in Chinese).

[9] Education Department of Tibet Autonomous Region. The notification on further completing college graduates' employment and entrepreneurship ([2016]8)[Z]. 2016 - 06 - 02. (in Chinese).

[10] Committee of Tibet Autonomous Region. The People's Government of the Tibet Autonomous Region gives some suggestions on promoting college graduates' employment and entrepreneurship([2017]9)[Z]. 2017 - 06 - 04. (in Chinese).

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[3] KAUR D, WANI AA, SOGI DS, *et al.* Sorption isotherms and drying characteristics of tomato peel isolated from tomato pomace [J]. Drying Technology, 2006, 24: 1515 - 1520.

[4] MAHERI-SIS N, CHAMANI M, SADEGHI AA, *et al.* Effects of drying and ensiling on in situ cell wall degradation kinetics of tomato pomace in ruminant [J]. Asian-Australasian Journal of Animal Sciences, 2012, 6: 196 - 202.

[5] ZIAEI N, MOLAEI S. Evaluation of nutrient digestibility of wet tomato pomace ensiled with wheat straw compared to alfalfa hay in kermani sheep [J]. Journal of Animal and Veterinary Advances, 2010, 9: 771 - 773.

[6] DENEK N, CAN A. Feeding value of wet tomato pomace ensiled with wheat straw and wheat grain dor Awassi sheep [J]. Small Ruminant Research, 2006, 65(3): 260 - 265.

[7] BARROSO FG, MARTINEZ TF, BERNAL A, *et al.* Alimentation de ovejas con ensilados basados en fruto del tomato [J]. Albeitar, 2008, 120: 6 - 9.

[8] ABDULLAHZADEH FR, PRIMOHAMMADI R, FARHOOMAND P, *et al.* The effect of ensiled mixed tomato and apple pomace on Holstein dairy cow [J]. Italian Journal of Animal Science, 2010, 9(2): 212 - 216.

[9] FONDEVILA M, GUADA JA, GASA J, *et al.* Tomato pomace as a protein supplement for growing lambs [J]. Small Ruminant Research, 1994, 13:117 - 126.

[10] AOAC. Official methods of analysis, 17th ed., Association of official analytical chemists [M]. Gaithersburg, MD, USA, 2000.

[11] VAN SOEST PJ, ROBERTSON JB, LEWIS BA. Methods for dietary fiber, neutral detergent fiber and non-starch polysaccharides in relation to animal nutrition [J]. Journal of Dairy Science, 1991, 74: 3583 - 3597.

[12] GRANT RJ, ALBRIGHT JL. Feeding behavior and management during the transition period in dairy cattle [J]. Journal of Animal Science and Technology, 1995, 73:2791 - 2803.

[13] VAN KEULEN J, YOUND BA. Evaluation of acid insoluble ash as a neutral marker in ruminant digestibility studies [J]. Journal of Animal Science and Technology, 1977, 44:282 - 287.

[14] MERTENS DR. Regulation of forage intake. In: forage quality, evaluation and utilization. G. C. Fahey, ed. Am. Soc. Agron [J]. Crop Sci. Soc. Amer., Soil Sci. Soc. Amer. Madison, WI, 1994.

[15] OLDHAM JD. Protein-energy interrelationships in dairy cows [J]. Journal of Dairy Science, 1984, 67:1090 - 1114.