Journal of Animal and Veterinary Advances 9 (17): 2261-2264, 2010
ISSN: 1680-5593

Growth Performance in Beef Cattle Fed Rations Containing Dried Tomato Pomace

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Abstract: There is evidence that the feeding of rations containing dried tomato pomace to beef steers inhibits ruminal fermentation and bacterial protein synthesis. These effects would be expected to reduce growth performance in growing beef steers. In this feeding trial, growing beef steers were fed total mixed rations in which soybean meal was replaced by dried tomato pomace. Increasing dietary inclusion levels of dried tomato pomace reduced final body weight in a linear, dose-dependent fashion. The inclusion levels of 3.2, 8.0 and 11.2% lowered final body weight by 2.4, 3.8 and 4.0%, respectively. Dried tomato pomace in the ration had a statistically significant, linear, diminishing effect on feed intake. The highest level of tomato pomace in the ration reduced feed intake by 6.5%. Feed conversion ratio was increased by feeding dried tomato pomace. Blood urea concentrations were raised. It is suggested that dried tomato pomace reduced growth by lowering feed intake which was caused by inhibition of ruminal fermentation. A simultaneous decrease in ruminal bacterial protein synthesis may have contributed to the observed decrease in growth. There may be place for dried tomato pomace in ruminant nutrition but only if the negative effects can be negated by appropriate ration formulation.

Key words: Beef cattle, growth, tomato pomace, soybean meal, Saudi Arabia, Thailand

INTRODUCTION

Dried tomato pomace is a by-product of the production of tomato paste and may be considered a possible ingredient of ruminant rations. Dried tomato pomace contains 20-25% crude protein, 9-12% ether extract and 57-67% neutral detergent fiber. So far the available data on the impact of dried tomato pomace on ruminant production appear to be conflicting and are difficult to interpret. Thus, further research is needed to determine the place of dried tomato pomace if any in ruminant nutrition.

When a mixture of tomato pomace and corn silage was fed to dairy cows, there was no effect on the production and composition of milk (Weiss *et al*., 1997). However, Yuangklang *et al*. (2005) showed that substitution of dried tomato pomace for soybean meal lowered milk protein concentrations.

The incorporation of tomato pomace into the barley based ration of young lambs did not affect growth performance (Fondevila *et al*., 1994) whereas in beef cattle the feeding of dried tomato pomace as sole source of roughage instead of either hay or fresh grass increased body weight gain (Satchaphun *et al*., 1998; Yuangklang *et al*., 2006). In contrast, studies on the effect of dried tomato pomace on rumen fermentation point at less fermentation and less bacterial protein synthesis (Yuangklang *et al*., 2007) indicating growth depression. In a recent study with rumen-fistulated beef steers (Yuangklang *et al*., 2010), it showed that the intake of dried tomato pomace versus soybean meal caused an increase in ruminal pH values, ruminal ammonia concentrations and blood urea concentrations. These effects showed a linear dependency on the dietary inclusion level of tomato pomace.

The observations suggest that dried tomato pomace reduces ferrmentation and bacterial protein synthesis in the rumen. These effects would be expected to reduce growth rates in young ruminants. However, as mentioned above there is no evidence for a negative effect of dried

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tomato pomace on growth performance. The discrepancies between the various studies could relate to the use of rations with different compositions. Therefore, the present feeding trial was carried out with growing beef steers fed the same rations as used in the study with rumen-fistulated beef steers.

MATERIALS AND METHODS

Animals and treatments: About 16 crossbred Brahman x Native steers, aged about 2 years were used in a randomized completed block design. There were four animals per dietary treatment. The steers were housed in individual pens. The experimental period lasted 120 days. The experimental, total mixed rations are shown in Table 1. Diet A did not contain tomato pomace, the inclusion levels of soybean meal and cassava chips being 40 and 11.2%. To formulate diets B, C and D increasing amounts of tomato pomace together with urea were added at the expense of soybean meal and cassava chips so that crude protein concentrations of the four rations were kept constant. Diets B, C and D contained 3.2, 8.0 and 11.2% dried tomato pomace, respectively. The steers had free access to feed and water. Feed intake and body weight were measured. At the end of experiment, blood samples were collected at 4 h post-morning feeding.

Chemical analyses: Diets were dried at 60°C for 72 h and then ground and analyzed for dry matter, crude ash, crude protein, Neutral Detergent Fiber (NDF) Acid Detergent Fiber (ADF) as described (Jansen *et al*., 2000). Blood samples were analyzed for Blood Urea Nitrogen (BUN) according to Bremner and Keeney (1965).

Statistical analysis: The data are presented as treatment means and SEM for four animals. The data were statistically analyzed using a computer program (SPSS for windows 9.0, SPSS Inc., Chicago, IL 1998). Linear, quadratic or cubic regressions were tested for the actual level of dried tomato pomace in the ration. None of the variables showed statistically, significant quadratic or cubic effects of the level of dietary tomato pomace. Significant differences between treatments were identified using Duncan's multiple range test. The level of statistical significance was pre-set at $p<0.05$.

Table 1: Ingredient and analyzed composition of the experimental rations

	Experimental rations			
Parameters	A	B	C	D
Ingredient (g)				
Cassava chip	11.2	8.0	3.2	0.0
Soybean meal	40.0	39.8	39.5	39.3
Dried tomato pomace	0.0	3.2	8.0	11.2
Urea	2.0	2.2	2.5	2.7
Constant components[1]	46.8	46.8	46.8	46.8
Total	100.0	100.0	100.0	100.0
Chemical composition (%)				
Dry matter	93.7	93.4	93.5	93.8
Ash	9.0	9.0	9.1	9.2
Crude protein	15.4	15.2	15.3	15.3
Ether extract	4.0	3.9	4.0	4.0
Neutral detergent fiber	40.6	38.3	42.1	41.4
Acid detergent fiber	28.9	29.6	28.4	28.6

[1]Constant components consisted of (g): milled rice straw, 20; whole cottonseed, 10.9; rice bran, 5.4; dried brewer grain, 5.5; salt, 0.9; sulfur, 0.2; di-calcium phosphate, 0.9; lime, 0.5; sodium bicarbonate, 1.0; tallow, 1.5

RESULTS AND DISCUSSION

Mean initial body weights of the treatment groups were similar (Table 2). Initial body weight on average was 258.6 kg. Increasing dietary inclusion levels of dried tomato pomace reduced final body weight in a linear, dose-dependent fashion. The inclusion levels of 3.2, 8.0 and 11.2% lowered final body weight by 2.4, 3.8 and 4.0%, respectively. Average daily gain was numerically lowered by the feeding of dried tomato pomace but the effect failed to reach statistical significance. Dried tomato pomace in the ration had a statistically significant, linear, diminishing effect on feed intake. The highest level of tomato pomace in the ration reduced feed intake by 6.5%. Feed intake expressed either as percentage of body weight or relative to metabolic weight was significantly lowered by the intake of tomato pomace. Feed conversion ratio was not significantly influenced by dietary treatment. However, the intake of dried tomato pomace raised feed conversion ratio by on average 4.1%. Blood urea concentrations were raised by the addition of dried tomato pomace to the ration (Table 2). The increase in blood urea showed a significant, linear trend. The highest inclusion level of dried tomato pomace increased blood urea by 13.3%.

In the previous study with rumen-fistulated beef steers (Yuangklang *et al*., 2010) and the present study with growing steers, the same rations were used. This

Table 2: Body Weight (BW), Average Daily Gain (ADG), Feed Conversion Ratio (FCR), Feed Intake (FI) and Blood Urea Nitrogen (BUN) concentrations

	Dietary treatment					
Characteristics	A	B	C	D	SEM	L
Initial BW (kg)	256.80	258.80	258.50	260.30	1.74	NS
Final BW (kg)	381.30^{a}	372.00^{b}	367.00^{b}	366.00^{b}	0.97	*
ADG (g day^{-1})	1037.00	943.80	904.20	881.30	13.90	NS
FCR	13.75	14.39	14.20	14.37	0.47	NS
FI (kg)	14.25^{a}	13.82^{b}	13.41^{b}	13.32^{b}	0.14	*
dry matter day^{-1}						
FI (BW%)	3.74^{a}	3.71^{ab}	3.66^{b}	3.65^{b}	0.05	*
FI (g kg^{-1}BW$^{0.75}$)	181.30^{a}	175.90^{ab}	173.50^{b}	173.30^{b}	1.98	*
BUN (mg %)	12.53^{b}	13.81^{a}	13.85^{a}	14.20^{a}	0.33	*

Statistical analysis: L = Linear effect: NS = Not Significant; * = $p<0.05$; Means in the same row not sharing the same superscript are significantly different

means that the outcomes of the two studies can be compared directly. Both in the rumen-fistulated (Yuangklang *et al*., 2010) and growing steers we found that increasing amounts of tomato pomace in the rations produced a dose-dependent rise in blood urea concentrations. In the rumen-fistulated beef steers, the feeding of dried tomato pomace produced an increase in ruminal ammonia concentrations, the increase showing a linear dependency of the dietary inclusion level of tomato pomace (Yuangklang *et al*., 2010). An increase in ruminal ammonia leads to an increase in blood ammonia which enhances ammonia uptake by the liver and subsequent conversion in urea (Gressley and Armentano, 2007). The increase in ruminal ammonia concentrations after the feeding of dried tomato pomace may relate to less bacterial protein synthesis and thus would depress growth. It was indeed found that the feeding of tomato pomace reduced growth in beef steers. The final body weights were significantly lowered by dried tomato pomace in a dose-dependent fashion. A similar pattern was seen for average daily gain but significance was not reached due to low statistical power.

It should be noted that the experimental rations had multiple variables due to the fact that they were formulated to be isonitrogenous. Increasing amounts of dietary levels of tomato pomace of the ration were accompanied by increasing amounts of urea, decreasing amounts of cassava chips and decreasing amounts of soybean meal. It could be argued that the observed diet effect on final body weights was caused by changes in the dietary concentrations of cassava chips, urea and/or soybean meal rather than the inclusion level of tomato pomace. At present, it not possible to assess to what extent the observed growth depression as induced by the feeding the test diets is specifically induced by dried tomato pomace or relates to the other dietary variables. In the rumen-fistulated beef steers, researchers found that the rations containing dried tomato pomace produced an increase in ruminal pH values (Yuangklang *et al*., 2010). It may be reasoned that the ingestion of dried tomato pomace reduced fermentation and thus slowed down the passage of feed through the rumen. This reasoning is in agreement with the observed dose-dependent decrease in feed intake on the rations with tomato pomace. It is likely that the decrease in feed intake is the major determinant of the observed growth depression after the addition of tomato pomace to the ration. This is further substantiated by the fact that feed intake expressed as a percentage of body weight was also reduced by tomato pomace. The decrease in voluntary feed intake was not the result of the lower body weight but rather was the cause. The feed conversion ratio was increased by the feeding of tomato pomace but there was no dose-response relationship. At the lowest dietary inclusion level the increasing effect of dried tomato pomace on the feed conversion ratio was already maximal. However, it is unlikely that the decrease in the efficiency of feed utilization was similar for all three rations containing dried tomato pomace. Feed utilization not only depends on body weight gain but also on body composition. It cannot be excluded that higher intakes of dried tomato pomace had induced an increase in body water, this effect counteracting the decrease in feed efficiency.

CONCLUSION

In conclusion, the present study shows that the addition of dried tomato pomace to a total-mixed ration for growing beef steers had a significant reducing effect on growth that was probably caused by a decrease in both feed intake and ruminal protein synthesis. Nevertheless, it can be suggested that there is a place for dried tomato pomace in ruminant nutrition provided that the inhibitory effects on ruminal fermentation and bacterial protein synthesis are taken into account by appropriate ration formulation. Further research is required to identify the characteristics of appropriate rations containing dried tomato pomace.

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