Tomato pomace as a protein supplement for growing Markhoz goat

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Abstract: This study was conducted to investigate the effect of dried tomato pomace (DTP) on the growth performance, nutrient digestibility and mohair production of Markhoz goats. Twenty four Markhoz male goat kids (BW = 18.6 ± 0.7 kg) were assigned randomly to 1 of 4 treatments and were fed with different levels of DTP (10, 20 and 30% DTP) for 94 days. The first group was fed a basal diet without DTP and considered as control, while the other three groups fed the basal diet after substituting part of the diet with DTP at 10, 20 and 30%, respectively. There was no significant ($P<0.05$) difference between experimental groups in live body weight, weight gains and feed intake. Differences between digestibility of DM, OM and NDF were not significant, while there was significant difference ($P<0.05$) in the CP digestibility between experimental diets and the diet contained 20% DTP had the highest values compared to other treatments. The inclusion of DTP in Markhoz goats' diet was associated with a higher ($P<0.05$) greasy fiber, fiber diameter and Barbe length than control diet. Results showed that DTP can be utilized efficiently and safely in the diets of Markhoz male goat kids to level up of 20% without any adverse effect on the growth performance, diet digestibility and mohair production.
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1. Introduction

Shortage of inexpensive feed resources often imposes major constrains on the promotion of animal production(Abdollahzadeh et al, 2010). Conventional feeds are the common known standards for supplying protein and energy needs of livestock. However, there are many suitable alternatives that may be considered to meet nutritional requirements while reducing the feeding cost. The tomato processing serves as an excellent example. The total waste produced from tomatoes from world production was estimated roughly to be 3.70 million ton per year (FAO, 1991). Tomato pomace (TP) is a mixture of tomato skin, pulp and crushed seeds that remain after the processing of tomato for juice, paste and or ketchup (Nobakht and Safamehr, 2007). This by product that remains from squeezing of tomato is rich in protein (21.7%), energy and crude fiber (Abdollahzadeh et al, 2010). Bordowski and Geisman (1980) reported that tomato seeds protein contained approximately 13% more lysine than soy protein, which would allow it to be used in fortifying low lysine feeds. Elloitt et al., (1981) demonstrated that TP is a good source of protein but may be limited in energy due to the high fiber content. Markhoz goat (Iranian Angora) with population at 25000 heads in 1996 is the only single coat goat producing shiny fine fibers in Iran (Bahmani et al., 2011). Fleece taken from Markhoz goat is called mohair. Mohair fiber is pure protein thus, Angora goats has a high protein requirement due to their rapid hair growth compared to other ruminant species. Sahlu, et al., (1992) reported that Angora goats require substantial amounts of dietary protein to produce mohair, in addition to meeting their nutrient requirements for maintenance, pregnancy, and lactation. Considering that the use of tomato processing by-products could provide extra income and at the same time reduce the waste disposal problem, the aim of the present research was to investigate the growth performance, digestibility and mohair production of Markhoz goat kids fed on different levels of dried tomato pomace (DTP).

2. Materials and Methods

The present study was designed to evaluate the effect of different levels of DTP (0, 10, 20, and 30%) of complete diets as a non-conventional ingredient on growth performance, digestibility and mohair production of Markhoz male goat kids. The feeding trial was carried out for 14 weeks (adaptation: 14 d and experimental period: 80 d).

2.1Tomato pomace preparation

Fresh experimental TP was collected from main factories in Urmia, Iran. The TP consisted mainly of skins, seeds and hard tissues of the whole tomatoes. The TP was subjected to the sun-drying until complete removal of moisture (less than10%). Then samples were taken for proximate chemical analyses.

2.2 Experimental diets

The experimental diets were prepared by thoroughly mixed the ingredients which composed of barley grain, soybean meal, wheat bran, chopped alfalfa hay, molasses and DTP. Four experimental diets were formulated to meet the nutrient requirements of growing kids according to AFRC (1998) guidelines to be isonitrogenic (CP, 16/00 % DM basis)and were offered twice daily in equal portions at 08:00 and 20:00 h to provide approximately 10% feed refusal as fed basis. The first group was fed a basal diet (0% DTP) and considered as control, while the other three groups were fed the basal diet after substituting part of the diet with DTP at 10, 20 and 30% respectively. Each diet was mixed completely and feed sorting by goats was minimal. Ingredients and composition of diets used in the study are given in Table1.

2.3 Animals, housing and feeding

Twenty four of Markhoz male goat kids of averaged 18.6 ± 0.7kg BW (4 months of age) were divided into four groups, of six each. Each treatment was assigned to one of four dietary treatments: 0, 10, 20 and 30% 0f DTP. Before initiation of the experiment, animals were allowed to adapt to treatment diets for 2 wk and were de-wormed with an effective anathematic and vaccinated against enterotoxaemia and foot and mouth disease. The goats were weighed before feeding in the morning at 14-d intervals throughout the experimental period and sheared before the beginning and at the end of the trials. They were housed and fed in individual metal-mesh cages and were adapted to human handling and the experimental setting. The floor area in each cage was 90*90 cm, and they were raised 85 cm from the floor. All the experimental animals were fed on the treatment diets ad-libitum. Fresh and clean water was available all time of experiment.

2.4 Digestibility study

Daily feed intake was monitored on individual goats and any refusals were collected, weighed and sampled for later analysis. The daily fecal matter excreted from each animal was collected during the collection period (last 6 days of the experiment) to plastic bags then weighed, sampled, mixed, dried at 60°C, ground and stored to be analyzed for different nutrients. From the analysis of the diets and fecal matter excreted, the digestion coefficient of dry matter and other nutrients were calculated according to the Maynard, (1979).

2.5 Measurements and laboratory analysis

At the beginning (d 0) and end (d 90) of the trial all goats were sheared. At the latter clipping, grease mohair weights were recorded and a sample from the mid-side area (10 × 10-cm) of each fleece was meticulously sheared. The samples were bagged separately in moisture proof- plastic bags and taken to the Wool Laboratory for yield, staple length, and proportions of Medullated and Kemp characterized. The sub samples were prepared for measurement with the projection microscope technique in accordance with ASTM, (1991) short – section procedure to determine fiber diameter, as well was paralleled in fibro liner component of Almeter 100 (Peyer Texlab FDA 200 Siegfried Peyer Ltd. Ch-8832 Wollerau – Switzerland), to determine the Simi rigid Hautuer (fiberpercent/number) and Barbe (fiber percent/ weight) length. Subsamples of diets, refusal and feces were ground through a 1.0 mm screen then analyzed for DM, CP (N x 6.251, ash, NDF, and ADF as described. Crude protein was calculated from Kjeldahl N values as total N x 6.25 (AOAC, 2000). Ether extract was determined using Soxhlet extraction procedure with anhydrous diethyl ether as the non-polar solvent. NDF and ADF were analyzed according to Van Soest et al. (1991). Ash was analyzed by ashing at 550°C, 6 h in a furnace. Calcium and phosphorus were measured by using an auto analyzer spectrophotometer (Unico, model S 2100 SUV, serial number 2165168, Japan).

2.6 Statistical analysis

Twenty four male goat kids arranged in balanced completely randomized design were used to evaluate the effects of feeding DTP on the growth performance, nutrient digestibility and mohair production. The collected data were subjected to statistical analysis using the Duncan procedure of SAS, (1998) (SAS Inst. Inc., Cary, NC). Level of significance was α=0.05, and the Duncan's multiple test was used to compare differences between treatments. The model used for this analysis was:

$$\hat{Y}ij = \mu + Ti + \sum ij$$

Where Y is the dependent variable; μ is the overall mean; T is the DTP effect level (i= 10, 20 and 30% of diet) and Σ is the random residual error term on the third day of treatment, atretic follicles, and decreased oviduct weight.

Table 1. Ingredients and nutrient composition of experimental diets (DM basis)

	Diets (DTP levels)‡			
	Control	**1**	**2**	**3**
	0%	10%	20%	30%
Ingredients				
Alfalfa hay	39.00	37.60	31.14	30.00
DTP‡	00	10.00	20.00	30.00
Soy bean meal	11.50	6.00	5.00	2.20
Barley grain	31.95	20.00	27.00	26.75
Wheat bran	11.60	20.8	10.50	5.00
Molasses	5.00	5.00	5.00	5.00
Calcium carbonate	0.450	0.440	0.450	0.450
Premix†	0.50	0.50	0.50	0.50
Nutrient content		**(% based DM)**		
DM	78.0	78.3	78.1	79.4
CP	16.00	16.00	16.00	16.00
NDF	35.4	35.2	35.1	36.3
ADF	21.4	23.1	24.3	24.00
Calcium	0.6	0.61	0.58	0.57
Phosphorus	0.4	0.39	0.43	0.42

‡Diets; control = (0% DTP); 1= (10% DTP); 2= (20% DTP); 3=(30%DTP); DTP, dried tomato pomace; DM, dry matter; CP, crude protein; NDF, neutral detergent fiber; ADF, acid detergent fiber. †Premix supplied (on a concentrate DM basis): Each 3 kg contain: vitamin A, 12.000.000 IU; vitamin D, 2.500.000 IU; vitamin E, 10.000 mg; vitamin K3, 1000 mg; vitamin B1, 1000 mg; vitamin B2, 5000 mg; vitamin B6, 1500 mg; niacin, 30.000 mg; biotin, 50 mg; folic acid, 1000 mg; pantothenic acid, 10.000 mg; Mn, 60.000 mg; Zn, 50.000 mg; Fe, 30.000 mg; Cu, 5.000 mg; Se, 100 mg; Co, 100 mg; Mn, 250.000 mg; CaCo3, up to 3kg.

3. Results and Discussion

3.1 Live body weight and weight gain

Mean values of live body weight and weight gain are presented in Table 2. Results showed that difference between experimental treatments in the live body weight and weight gain was not significant ($P<0.05$). Goats fed the diet contained 20%DTP recorded the highest average body weight (29.12kg) and daily gains (116.8 g), while goats fed 30% DTP diet showed the lowest values of live body weight (26.1kg) and daily gains (81.1g). These results were accordance with Fondevila et al. (1994) and Ibrahem and Alwash, (1983) who reported that diets with up to 50% dried tomato pomace (used to replace alfalfa hay or barley straw) did not affect average daily gain of lambs. On contrary, Weiss et al., (1997) showed that TP did not affect live body weight, when fed to lactating dairy cows.

3.2 Feed intake and nutrient digestibility

The apparent digestibility of diet nutrients and mean daily DM intake are presented in Tables 2 and 3. The results (Table3) showed that some nutrients digestibility tended to be increased when TP substituted in diets. Digestible CP content of diets increased significantly compared to control diet and CP digestibility values of 10% DTP and 30% DTP treatments were similar, but CP digestibility of 20% DTP treatment was highest. Differences between TP levels were not significant ($P<0.05$). These findings are in accordance with those reported by Tahmasbi et al. (2002), who reported that increasing TP level in corn silage increased CP digestibility of the silage. Fondevila et al., (1994), concluded that supplementation of barley-based diets with TP at a rate of 200 g/kg ration DM promote similar N retentions and growth performances to soybean protein in young lambs up to 28 kg BW. Table 2 showed that, no significant differences were observed in DM intake but, goats fed the diet contained 30% DTP level consumed the lowest amount of feed (564.0g), while goats fed the diet contained 10% DTP consumed the highest amount of feed (590.3g). These results were agreed with that of others, Ibrahem and Alwash, (1983); Fondevila et al. (1994) and Denek and Can, (2006) (growth studies with lamb) Belibasakis, (1990); Belibasakis and Ambatzidiz (1995) and Weiss et al., (1997) (with lactating dairy cow). Present results is contrast with our previous findings (Abdollahzadeh et al., 2010), as reported that DM intake

linearly increased (P<0.05) when TP and AP (apple pomace) was fed together (with ratio of 50:50 on DM basis) and used in dairy cow diet.

Table 3. Nutrient digestibility of goats fed diets differing in ratio of DTP.

	Diets (DTP Levels) ‡					
	Control 0%	**1** 10%	**2** 20%	**3** 30%		
Items					**S.E.M**	**P value**
DM	65.24	65.09	66.04	64.4	0.6	>0.05
OM	67.30	67.36	67.41	67.01	0.5	>0.05
CP	6o.19^{b}	62.2^{ab}	63.24^{a}	62.2^{ab}	0.14	<0.05
NDF	57.02	59.01	58.60	56.4	0.27	>0.05

‡Diets; control = (0% DTP); 1= (10% DTP); 2= (20% DTP); 3=(30%DTP) S.E.M = standard error of means

Table (4): Mean values of fleece characteristics of goats fed different levels of DTP.

	Diets (DTP Levels) ‡					
	Control 0%	**1** 10%	**2** 20%	**3** 30%		
Items					**S.E.M**	**P value**
Greasy fibers (g)	453^{ab}	451^{b}	493^{a}	470^{ab}	0.34	<0.05
Clean fiber, %	77.30	76.8	79.68	80.14^{b}	0.5	>0.05
Fiber diameter (µm)	87.7^{b}	105.1^{ab}	116.8^{a}	81.1^{b}	0.14	<0.05
Staple length, cm	4.32	5.03	5.86	5.64	0.27	>0.05
B Length	31.77^{b}	35.61^{ab}	45.01^{ab}	45.95^{a}	0.23	<0.05
H Length	34.60	34.43	36.87	36.76	0.45	>0.05
Med fiber,%	2.17	3.6	3.67	2.87	0.16	>0.05
Kemp fiber,%	1.70	3.22	4.41	4.67	0.33	>0.05
True fiber, %	96.13	93.18	91.92	92.45	0.24	>0.05

‡Diets; control = (0% DTP); 1= (10% DTP); 2= (20% DTP); 3=(30%DTP) S.E.M = standard error of means

Table (2): Mean values for performance of growing goats fed different levels of DTP

	Diets (DTP Levels) ‡					
	Control 0%	**1** 10%	**2** 20%	**3** 30%		
Items					**S.E.M**	**P value**
Initial body weight(kg)	18.5	18.9	18.6	18.8	0.14	>0.05
Final body weight (kg)	27.30	28.36	29.12	26.1	0.5	>0.05
Daily weight gain (g)	97.7	105.1	116.8	81.1	0.14	>0.05
Daily feed intake (g)	570.3	590.3	586.0	564.0	0.37	>0.05
Feed conversion	5.83	5.61	5.01	6.95	0.23	0.14

‡Diets; control = (0% DTP); 1= (10% DTP); 2= (20% DTP); 3=(30%DTP) S.E.M = standard error of means

3.3 Mohair production, quantity and quality traits

Influence of diets differing in ratio of DTP on the quantity and quality of fiber produced by Markhoz goat kids are presented in Table 4. Goats fed DTP containing diets produced higher amount of greasy fiber, fiber diameter and Barbe length than control diet but, differences between amount of med and kemp fiber, clean fiber, staple length, Hautuer length and true fiber were not significant. The kind or quality of protein consumed by Markhoz goat, owing to their rapid hair growth is very important. The higher ($P < 0.05$) produced mohair by goats fed DTP containing diets compared to control diet may have reflected enhance of microbial growth and thereby ruminal fermentation as well, provide a reasonable high quality source of amino acids by DTP to the intestines. Production efficiency would potentially be improved if a large proportion of feed proteins could get through the rumen without being degraded. Huston,et al., (1993) reported that, fishmeal are effective protein source for goats and may be of greater value than oilseed byproduct meals in stimulating mohair growth because of their comparatively low ruminal protein degradation.

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