



Pistachio by-product as an alternative forage source for male lambs: Effects on performance, blood metabolites, and urine characteristics



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ARTICLE INFO

Article history:

Received 3 June 2015

Received in revised form

18 November 2015

Accepted 19 November 2015

Keywords:

Pistachio

Lambs

Tannin

Performance

Digestibility

Urine

ABSTRACT

Thirty-two Kermanian male lambs (5–6 months of age and 23.73 ± 2.20 kg BW) were used to determine the effects of feeding sun-dried pistachio by-product (PBP) on growth performance, nutrients digestibility, blood metabolites, and urine characteristics over a 4-months period. Lambs were randomly allocated to one of four experimental diets containing 0 (DM basis; 0PBP), 10 (10PBP), 20 (20PBP), and 30% of PBP (30PBP), substituted with alfalfa hay and wheat straw. Experimental diets were fed twice daily in two equal portions as pelleted total mixed rations. Lambs were weighed at the beginning of trial and the end of each month over the experimental period. Blood and urine samples were also collected monthly. Eight Kermanian castrated rams (48.35 ± 2.81 kg BW) placed in metabolic cages were used in a replicated 4×4 Latin square design during four 3-week periods to evaluate nutrient digestibility in response to feeding experimental diets. Dry matter intake (DMI) and average daily gain (ADG) reduced linearly ($P = 0.001$) with increasing the amount of PBP in the diets. The lambs fed 30PBP, had the lowest daily DMI and ADG, which were lower ($P < 0.01$) than the control group (1549 g/d vs. 1063 g/d and 195.7 g/d vs. 129.4 g/d, respectively). Feed conversion ratio increased linearly and it was greater ($P < 0.05$) in 30PBP than the control group (13.82 vs. 7.96). Plasma activities of circulating enzymes including alanine aminotransferase and aspartate aminotransferase as indicators of liver function were not affected by experimental diets. Blood urea nitrogen responded quadratically ($P = 0.001$) and decreased in lambs fed 30PBP in comparison with lambs fed the control diet (13.52 vs. 16.21 mg/dl). Urine characteristics including pH, specific gravity, and the counts of white and red blood cells and also epithelial cells were not different across experimental diets. Apparent total tract digestibility of DM and CP reduced linearly ($P < 0.01$) with increasing the amount of PBP in the experimental diets; however, ether-extract and ash digestibility were not affected by diets. Results indicate that using PBP to replace alfalfa hay and wheat straw up to 20% of dietary DM had no negative effects on feed intake and growth performance in Kermanian male lambs.

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Abbreviations: ADF, acid detergent fiber; ADG, average daily gain; ALT, alanine aminotransferase; AST, aspartate aminotransferase; BUN, blood urea nitrogen; CP, crude protein; DM, dry matter; DMI, dry matter intake; NDF, neutral detergent fiber; PBP, pistachio by-product; TP, total phenolic compounds; TT, total tannins.

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1. Introduction

For the most part of Iran and countries located in semi-arid and arid areas, low precipitation and limited water resources are the principle factors limiting forage production. Feeding agricultural by-products in livestock production has recently received great attention by farm animal producers and nutritionists in order to reduce the dependence of livestock on grains, to decrease feeding costs, to reduce environmental pollution, and to promote recycling crop materials which would have been wasted otherwise (Vasta et al., 2008). According to the Food and Agriculture Organization (FAO, 2012), Iran is the highest producer of pistachio worldwide and has an annual production of about 500,000 tons of fresh pistachio by-product (PBP) (Shakeri et al., 2013). Pistachio by-products (PBP) are produced during the de-hulling process of the crop (1.25–2 kg PBP/kg dry pistachio) and it consists of high levels of pistachio epicarp and, to a lesser extent, peduncles, leaves, mesocarp, kernel and cluster (Shakeri et al., 2014).

PBP consisted of (DM basis) high non-fiber carbohydrates (36.9–40.4%) with moderate crude protein (11.4–13.0%) and neutral detergent fiber (30.9–33.3%) (Shakeri et al., 2014; Ghaffari et al., 2014a). It seems to be a suitable source of energy and protein for ruminant animals due to its low price and availability to ruminant animals. Pistachio by-products (as sun-dried or as silage) are recently been used in diets for dairy cows (at a level of 15% of dietary DM) (Mokhtarpour et al., 2012), growing calves (at a level of 18% of dietary DM) (Shakeri et al., 2014) and Saanen dairy goats (at a level of 30% dietary DM) (Ghaffari et al., 2014b). Phenolic compounds and tannins have been identified in PBP (Mahdavi et al., 2010; Ghaffari et al., 2014a). The total phenolic compounds and tannins of sun-dried PBP have been reported to be 7.6–15.6% and 3.4–10.2% on DM basis, respectively (Mahdavi et al., 2010; Norouziyan and Ghiasi, 2012; Mokhtarpour et al., 2012; Shakeri et al., 2014). The anti-nutritional factors, during long period feeding, may have adverse effects on growth performance of ruminants (Mahgoub et al., 2008; Shakeri et al., 2014). Filippich et al. (1991) reported that hydrolysable tannins in some feedstuffs have the potential to cause gastrointestinal hemorrhage, liver necrosis and kidney damages. Furthermore, Mahdavi et al. (2010) suggested that high levels (30% of dietary DM) of PBP fed for 90-d had negative effects on Afshari lambs' growth. To the best of our knowledge, there is limited information on feeding PBP to lambs. Therefore, the objective of this study was to determine a part of alfalfa hay and wheat straw can effectively be replaced by PBP in Kermanian lambs diets and also to determine its effect on nutrient digestibility, blood biochemical parameters, urine characteristics, and growth performance.

2. Materials and methods

The experiment was conducted at the Research Farm of the Department of Animal Sciences, Kerman Agricultural and Natural Resources Research Center. Kerman is located in arid area with average annual rainfall of 200 mm and maximum annual temperature of 40 °C. The experimental protocols were reviewed and approved by the Animal Care Committee of Research Institute of Animal Science, Iran.

2.1. Preparation of PBP

Approximately five metric tons of fresh PBP containing soft hulls, twigs, leaves, little amount of hard shells and green kernels were obtained from de-hulling factories located at Kerman town (Kerman Province, Iran) and then sun-dried before being used in the current study.

2.2. Chemical analysis

Representative samples of PBP were ground using a Willey mill (Arthur H. Thomas, Philadelphia, PA, USA) to pass through a 1-mm mesh screen. Ground samples were analyzed for ash (method 942.05; Shimifan F-47, Tehran, Iran), ether extract

Table 1
Chemical composition^a of sun-dried pistachio by-product ($n = 3$; mean \pm SD).

Chemical composition	Proportion (%)
DM	95.8 \pm 0.31
CP	10.5 \pm 0.16
NFC	51.7 \pm 0.32
NDF	23.6 \pm 0.61
ADF	17.4 \pm 0.39
EE	4.2 \pm 0.19
Ash	10.0 \pm 0.31
TP	10.8 \pm 0.22
TT	7.6 \pm 0.10
ME (Mcal/kg)	2.0 \pm 0.08

^a DM, dry matter; CP, crude protein; NFC, non fiber carbohydrate = 100 – (%NDF + %CP + %EE + %Ash); NDF, neutral detergent fiber; ADF, acid detergent fiber; EE, ether extract; TP, total phenolic compound; TT, total tannins; ME, metabolizable energy, determined via gas production assay.

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