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Performance and carcass characteristics in fattening lambs feed diets with different levels of pistachio by-products silage with wasted date

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ABSTRACT

Forty Kermani fattening male lambs (21 ± 1.4 kg body weight (BW) and six months old) were assigned to a completely randomized design to determine the effects of feeding pistachio by-products silage with wasted date (PBSWD) on dry matter intake (DMI), live weight gain, feed conversion and carcass characteristics. Two thousand kg of fresh pistachio by-products (PBP) were mixed thoroughly with 400 kg Mazafati wasted date and ensiled for 2 months. Experimental diets were: (1) control (without PBSWD); (2) diet containing 7% PBSWD; (3) diet containing 14% PBSWD and (4) diet containing 21% PBSWD. All diets were formulated to contain 60% concentrate and 40% forage (dry matter (DM) basis). The lambs were divided into four equal groups and fed the diets for a 90-day experimental period. At the end of the experiment, all animals were slaughtered on the same day. Ensiling of PBP with wasted date increased the DM and metabolisable energy (ME), but decreased ($P < 0.05$) the percentages of crude protein, ether extract, total tannins and phenolic compounds. Lambs fed the 14 and 21% PBSWD diets had more ($P < 0.05$) DMI than those fed control diet. Feeding 21% PBSWD increased ($P < 0.05$) final BW, weight gain, the weights of warm and cold carcass, liver, loin, lean meat, reproductive system and small intestine, and the eye muscle area,. Lambs fed 21% of PBSWD had higher ($P < 0.05$) back fat depth than lambs fed control diet. Results showed that feeding 21% PBWDS to fattening lambs increased their feedlot performance and lean meat yield.

1. Introduction

Annual production of pistachio in Iran is approximately 478,000 t (FAO, 2014). Pistachio by-product (PBP), consisting of the soft external hulls, twinges, leaves, some kernel and bony shells, remains after de-hulling process of harvested pistachio (1.25–2 kg PBP/kg dry pistachio; Shakeri and ForoughAmeri, 2008). High amounts of PBP production in a limited time (1.5–2 months), drying problems, traditional disposal methods, and environmental contamination during the storage period limit the use of this by-product as animal feed (Bagheripour et al., 2008; Shakeri and ForoughAmeri, 2008; Shakeri and Dayani, 2007). Some researchers (Shakeri, 2016; Ghasemi et al., 2012; Rezaei et al., 2012) reported that PBP has a potential nutritive value in ruminant nutrition. However, some anti-nutritional factors, such as phenolic compounds, may reduce the availability of nutrients for animals (Bohluli et al., 2009; Bagheripour et al., 2008; Shakeri and Dayani, 2007). According to Vahmani et al. (2006), ensiling could reduce the total tannins and phenolic compounds in comparison with sun-dried PBP.

Date palm (*Phoenix dactylifera* L.) is one of the oldest fruits grown in the arid and semiarid regions of the Middle East (Chao and Krueger, 2007). In Iran (especially South-Eastern area) more than a half-million tons of date palm is produced annually, making it one of the highest producers in the world (Dayani et al., 2012). Wasted dates are high in sugar and palatable for livestock (Khezri et al., in press a,b), and can be used as a proper silage additive.

Ensiling PBP is one of the best methods for long term preservation as its high moisture content makes it difficult to preserve. To avoid spoilage, reduce the total tannin and phenolic compounds, and increase its nutritional value, PBP can be ensiled with wasted date for feeding ruminants. Therefore, the objectives of the present study were to determine the effect of diets containing pistachio by-products silage with wasted date on feedlot performance of male lambs.

2. Materials and methods

2.1. Silage preparation and chemical composition

During the harvest season, 2000 kg of fresh PBP (supplied by a pistachio de-hulling factory in Kerman, Iran) was ensiled with 400 kg Mazafati wasted dates with a density of 650 kg/m^3 into a

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concrete walled bunker silo (2.3 W × 1.6 L × 1 H meter). Mazafati wasted dates contained 90% DM, 97.6% OM, 7% CP, 0.35% EE, sugar 64%, 23.3% NDFom, 17.2% ADFom and 2.9 Mcal/kg ME (Khezri et al., in press a,b):). After 2 months, fifteen samples were prepared using a specific probe from across the surface of the ensilage (2.3 W × 1 H meter). The samples were thoroughly mixed, five sub-samples placed in plastic bags and the air inside was removed by squeezing. Bags were sealed immediately and kept frozen until further laboratory analysis. The PBSWD samples were freeze-dried and then ground using a Wiley Mill (Arthur H. Thomas, Philadelphia, PA, USA) to pass through a 1-mm mesh screen. Ground composited samples were analyzed for DM, CP, EE and ash (AOAC, 2000). Neutral (NDFom) and acid (ADFom) detergent fibers, expressed exclusive of residual ash, were determined according to Van Soest et al. (1991). For tannin assay, samples were dried at 40 °C to a constant weight to minimize changes in tannin content and activity, and dried samples were ground through a 0.5-mm screen before analysis (Makkar, 2003). Phenolic compounds were extracted using 200 mg of dried sample. The extraction procedure involved mixing the sample with 10 mL aqueous acetone water (700:300, v/v), and keeping the mixture at 4 °C overnight. The extract was centrifuged (3000 g, 4 °C, 15 min) and the supernatant used for analysis. The concentration of total phenolic compounds (TP) was determined using the Folin–Ciocalteu procedure (Singleton and Rossi, 1965) and the regression equation of tannic acid (Merck GmbH, Darmstadt, Germany) standard. Total tannins (TT) were estimated indirectly after being absorbed to insoluble polyvinylpolypyrrolidone (PVPP). Concentration of TT was calculated by subtracting the TP remaining after the PVPP treatment in the assay mixture (Makkar, 2003). The ME contents of the silage samples were estimated by using the following equation (Moran, 2005): ME (MJ/kg) = (0.16 × % digestible dry matter (DDM))—0.8. The samples DDM (%) were determined according to Tilley and Terry (1963).

2.2. Animals and diets

The feedlot trial was conducted using 40 Kermani male lambs (six month old) with a mean live weight of 21 ± 1.4 kg. The animals were allocated to four treatments of ten lambs per treatment according to a completely randomized design. Lambs were housed in individual pens (1.2 × 1.5 m), with bedded straw, in a sheltered, cemented-floor, open-side barn, well-ventilated and equipped with adequate feeding and watering facilities. All animals were fed a control diet for 21 days prior to the start of the 90-day experimental period. Thereafter, one group (control) continued to receive the same diet while other groups received the diets containing PBSWD. Diets were fed as total mixed rations at 0800 and 1700 h for ad libitum intake to allow 10% orts, with half of the daily feed being offered at each feeding. Fresh, clean water was available at all times. Animals were maintained according to the guidelines set by the Iranian Council of Animal Care (1995). All lambs were shorn and treated with albendazole (Roacel) for internal parasites, and vaccinated against enterotoxemia (Razi Vaccine and Serum Research Institute). The animals were clinically examined during the study. All lambs were in good conditions with no cases of severe clinical disease observed.

Experimental diets were: (1) control (without PBSWD); (2) diet containing 7% PBSWD; (3) diet containing 14% PBSWD; (4) diet containing 21% PBSWD (DM basis). Ingredient composition of the diets is shown in Table 2. Samples (n = 5) of the experimental diets were ground (1-mm screen) and analyzed for DM, CP, EE and ash by AOAC (2000). The NDFom and ADFom were determined according to Van Soest et al. (1991).

Individual feed intake was calculated using daily feed offered and feed refuse averaged over the interval of the performance phase. Animal weights, determined by removing feed at 05:00 and weighing animals at 8:00, were obtained weekly during the performance phase. Average daily gain (ADG) was calculated as the difference between the initial and final weights over the interval of the performance phase (90 days).

Table 1
The chemical composition of the pistachio by-products silage with wasted date (PBSWD) and pistachio By-product (PBP) (n = 5, mean ± SD).

	By-products	
	PBP	PBSWD
pH	–	4.1 ± 0.03
Dry matter (%)	32.3 ± 0.41	40 ± 0.52
Crude protein (% of dry matter)	10.26 ± 0.23	8.3 ± 0.2
NH3-N (% of total nitrogen)	–	5.3 ± 0.15
Organic matter (% of dry matter)	94.35 ± 0.63	92.7 ± 0.
Ether extract (% of dry matter)	9.7 ± 0.15	4.57 ± 0.12
Ash (% of dry matter)	5.65 ± 0.26	7.3 ± 0.16
NDFom (% of dry matter)	34.34 ± 0.40	33.45 ± 0.30
ADFom (% of dry matter)	24.37 ± 0.47	22.65 ± 0.41
Total tannins (% of dry matter)	7.42 ± 0.8	4.82 ± 0.05
Phenolic compounds (% of dry matter)	12.48 ± 0.32	9.65 ± 0.25
Metabolizable energy (MJ/kg DM)[a]	10.39 ± 0.05	10.6 ± 0.04

NDFom, NDF expressed exclusive of residual ash.
ADFom, ADF expressed exclusive of residual ash.
[a] Metabolizable energy, estimated by equation (Moran, 2005): ME (MJ/kg) = (0.16 × % DDM)—0.8.

2.3. Carcass analyses

All animals were slaughtered on the same day at the end of trial (i.e., 90 days) in a slaughterhouse in Kerman city. After the lambs were bled, they were pelted and the head severed at the atlas joint. The weights of head, feet and pelt were recorded. The lambs were then eviscerated, and the internal organs were removed for measurements. The carcasses were hung by the Achilles tendon after slaughter. Warm and cold (i.e., after 24 h chilling at 4 °C) carcass weights without head were recorded. Stomachs plus contents were weighed. The reticulo-rumen was separated from the omasum and abomasum and all compartments were emptied, washed and weighed. The intestines were emptied and weighed. Intestinal fat, perirenal fat, liver, lungs, spleen, pancreas, gallbladder and heart were also weighed. The dressing percentage was calculated as follows: (weight of carcass/live weight at slaughter) × 100. Cooler shrink refers to the loss of carcass weight between 0 and 24 h. The carcass was split, along the median line, into two parts. The right sides of carcass was dissected into six cuts (neck, shoulder, brisket, loin, legs and fat-tail) according to Kashan et al. (2005), and were weighed separately. Individual parts were then dissected into lean meat, bone, trimmings and weighed separately.

2.4. Statistical analyses

Data from chemical analysis of PBP and PBWDS were subjected to analysis of variance as a completely randomized design. The Mixed procedure (SAS, 2005) was used to determine statistical differences between treatments in growth performance, offals and commercial joints, and carcass data. The initial live weight was used as the co-variate for final BW, and the carcass weight was used as a co-variate for analysis of carcass components. The Tukey's test was used to compare means. Effects were considered significant at $P < 0.05$.

3. Results

The chemical compositions of PBWDS and PBP are shown in Table 1. Ensiling of PBP with wasted dates, increased the DM and metabolizable energy contents, but decreased the percentages of