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Effects of dietary pomegranate byproduct silage supplementation on performance, carcass characteristics and meat quality of growing lambs

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ABSTRACT

In an experiment with 24 male growing Florina (Pelagonia) lambs, effects of dietary pomegranate byproduct silage (PS) on performance, carcass characteristics and meat chemical and fatty acid composition were determined. In the 9 week experiment, lambs were allocated to one of three dietary treatments (PS0, PS120, and PS240) of 8 lambs each. Lambs had an initial body weight (BW) of 18.8 ± 2.28 kg, and were fed one of three isonitrogenous (crude protein 171 g/kg, dry matter – DM basis) and isoenergetic (net energy for gain 5.62 MJ/kg, DM basis) total mixed rations (TMRs) *ad libitum*. The PS was added to the TMR at inclusion levels (as mixed basis) of 0, 120, and 240 g/kg DM for treatments PS0, PS120, and PS240, respectively. No differences (P>0.05) occurred among PS treatments in final BW (34.3 kg), BW gain (0.24 kg/day), DM intake (0.94 kg/day), and FCR (3.95 kg DM intake/kg BW gain). Moreover, carcass characteristics were not affected (P>0.05) with increased PS feeding, except for the fat color, fat firmness, wetness and overall acceptability of carcasses, which improved (P<0.05). Fat content of meat was linearly increased (P<0.001) with increasing PS in lambs TMRs. PS supplementation caused linear (P<0.05) and quadratic (P<0.01) effect on 11-Hexadecenoic concentration and a linear decrease (P<0.05) in 6-9-Hexadecenoic and *cis*-11, 14-eicosadienoic acids concentrations, in intramuscular fat. A linear increase (P<0.05) was observed in linoleic acid and *trans*-10, *cis*-12 conjugated linoleic acid (CLA) (P<0.05) concentration, with increasing PS inclusion levels and a quadratic (P<0.05) and linear (P<0.01) effect on α-linolenic acid concentration. Meat total phenolic content increased linearly (P<0.05) and antioxidant activity was linearly (P<0.05) and quadratic affected (P<0.05), with maximum levels observed in intermediated group (PS120). Pomegranate byproduct silage supplementation, at levels up to 240 g/kg DM of TMR, in isonitrogenous and iso (net energy) energetic diets for growing lambs did not

Abbreviations: ADF, acid detergent fiber; BW, body weight; CLA, conjugated linoleic acid; CP, crude protein; DHA, cis-4, 7, 10, 13, 16, 19 Docosahexaenoic acid; DM, dry matter; DPPH, 1,1-Diphenyl-2-Picrylhydrazyl; EPA, cis-5, 8, 11, 14, 17-Eicosapentaenoic acid; FA, fatty acid; FAME, methyl esters; FCR, feed conversion ratio; GAE, gallic acid equivalents; MUFA, monounsaturated fatty acid; NDF, neutral detergent fiber; PS, pomegranate byproduct silage; PUFA, polyunsaturated fatty acid; SFA, saturated fatty acid; TMR, total mixed ration.

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affect their performance and carcass quantitative characteristics, but improved qualitative carcass characteristics. More significantly, dietary PS supplementation improved the nutritional and functional qualities, as well as the antioxidant potential of meat, as indicated by the increase in essential fatty acids, linoleic, α-linolenic acid and *trans*-10, *cis*-12 CLA, in intramuscular fat and the increase in total phenolic content and antioxidant activity.

1. Introduction

Nowadays, there is great political and social pressure to reduce the pollution arising from industrial activities. Almost all developed and underdeveloped countries are trying to adapt to this reality by modifying their processes so that their residues can be recycled. Consequently, wastes are no longer considered as residues, but as a raw material for other processes. Most byproducts result from the processing of commercial crops, the food processing industry and the fiber industry, many of which have a substantial potential value as animal feedstuffs that could support growth and lactation and result in the production of human edible foods. Many agro-industrial byproducts would be discarded in landfills if they were not fed to farm animals. Byproduct feedstuffs, in the diets of farm animals, are becoming increasingly more important in the food and fiber system because they are available for use as livestock feeds at competitive prices relative to other commodities. These byproducts, which contain little economical value as edible foods for human consumption have become major sources of dietary nutrients and energy in support of milk production and will continue to do so in the future (Bampidis and Robinson, 2006).

Pomegranate (*Punica granatum* L.; Punicaceae) is a native fruit to areas from Iran to the Himalayas in northern India, but has been widely cultivated and naturalized since ancient times over the entire Mediterranean basin. Recently, the global production and consumption of pomegranate has greatly expanded, together with the recognition of the health-promoting potential of various components of this fruit (Shabtay et al., 2008). These trends have led to the development of advanced industrial technologies, which provide consumers with "ready to eat" pomegranate arils and several food products, along with the accumulation of a new agro-industrial byproduct biomass, namely pomegranate peel (Shabtay et al., 2008). About 500 g/kg of the total fruit weight corresponds to the peel, while the rest are the edible parts of pomegranate, consisting of 400 g/kg arils and 100 g/kg seeds (Aviram et al., 2000). Recently, pomegranate byproducts have attracted attention, as they have been found to contain substantial amounts of polyphenols such as ellagic tannins, ellagic acid, punicalagin and gallic acid (Jami et al., 2012), which have been shown to possess antimicrobial, antioxidant, antiinflammatory, antimitotic, and immunomodulatory properties both *in vivo* and *in vitro* (Adams et al., 2006; Jayaprakasha et al., 2006; Rosenblat and Aviram, 2006).

Pomegranate byproducts are produced in huge amounts in many parts of the world, while, due to their beneficial properties, pomegranate peels and their extracts have recently attracted attention in animal nutrition. They can be fed in fresh form to ruminants, but due to their potential for rapid spoiling, they are usually preserved, with drying and ensiling being well known forage preservation methods (McDonald et al., 1990). At present, research on the use of pomegranate and its byproducts in animal nutrition, is limited and restricted to the use of pomegranate extracts (Oliveira et al., 2010; Shabtay et al., 2012), pomegranate seeds (Modaresi et al., 2011) and fresh pomegranate peels (Shabtay et al., 2008) in ruminants nutrition. As there is no information on the nutritional value of pomegranate byproduct silage (PS) for ruminants, the objective of this study was to evaluate PS supplementation in diets of weaned Florina (Pelagonia) lambs, relative to performance and carcass characteristics, as well as to meat nutritional and functional quality, relative to fatty acids (FA) composition, phenolic content and antioxidant activity.

2. Materials and methods

2.1. Pomegranate byproduct silage

Pomegranate byproduct silage (PS) was used in an experiment with growing lambs, at the Animal Research Institute, Hellenic Agricultural Organization–Demeter (Giannitsa, Greece; 40°44′ N, 22°27′ E). Pomegranate byproduct (peels, seeds and a small portion of arils) was obtained after juice extraction from a local private agro-industry (Rodi Hellas S.A., Pella, Greece). Immediately after its production, pomegranate byproduct was stored and ensiled under the common practice of ensilage. Two months later representative samples of PS were obtained for chemical analysis (Tables 1 and 2).

2.2. Growing lambs experiment

Partial and total replacement of alfalfa hay, and barley grain with PS, wheat straw, wheat bran, and vegetable fat in the rations of growing lambs was determined with 24 weaned male lambs of the Florina (Pelagonia) breed (65 ± 5 days of age) in a 9 week study. All lambs used in the experiment were cared for according to applicable recommendations of the U.S. National Research Council (1996). Lambs, after individual weighing, were randomly allocated into three dietary treatments