



Effect of dietary grape pomace on growth performance, meat quality and antioxidant activity in ram lambs

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ABSTRACT

Wine grape pomace (WGP) provides a rich source of polyphenols that can act as powerful antioxidants, but their potential as feed ingredients in the lamb industry remains unexploited. The objective of this study was to investigate the effect of dietary WGP supplementation on growth performance, meat quality and antioxidative activity in the *longissimus dorsi* (LD) muscle of lambs. A total of eighteen lambs (25.0 ± 0.2 kg of body weight, BW) were randomly selected and equally divided into three groups, and offered diet containing different levels of WGP (0%, 5% and 10%). The results showed that supplementation with 10% dietary WGP increased body weight, average daily gain, and reduced the feed to gain ratio ($P < 0.05$). There was no observed effect of dietary WGP supplementation on pH, color, cooking loss, or intramuscular fat (IMF). Lambs fed with a WGP-containing diet had lower Warner–Bratzler shear force (WBSF) ($P < 0.05$), and a decreased collagen content ($P < 0.05$). The total antioxidative capacity (T-AOC), glutathione peroxidase 4 (GPx4) and superoxide dismutase (SOD) activity were increased when lambs were fed the WGP-containing diet ($P < 0.05$), whereas no difference in catalase activity was detected. In addition, WGP supplementation decreased ROS and MDA levels induced in animals raised in penned conditions ($P < 0.05$). Taken together, these results suggest that WGP can be used as a feed ingredient in lamb production to relieve oxidative stress, and improve feed efficiency and meat tenderness, possibly due to the enhanced antioxidative capacity.

1. Introduction

Wine grape pomace (WGP) is rich in extractable polyphenols, including phenolic acid, flavonoids, procyanidins, resveratrol and anthocyanins (Xia et al., 2010), and their biological functions have been extensively studied (Cottart et al., 2014). The application of WGP as feed supplements provides promising possibilities to improve animal growth performance and meat quality. In broiler chicken, dietary WGP supplementation has been demonstrated to improve antioxidant capacity in breast and thigh meat (Goñi et al., 2007). In pigs, dietary resveratrol supplementation improves meat quality (Zhang et al., 2015). Moreover, dietary WGP reduced palmitic acid, stearic acid and arachidic acid levels, and increased linoleic acid in subcutaneous fat of pigs (Yan and Kim, 2011). In addition, addition of antioxidants extracted from grape to meat and meat products improves products shelf life by protecting against deterioration (Brannan, 2008; Garrido et al., 2011; Jeronimo et al., 2012).

Abbreviations: WGP, wine grape pomace; LD, *longissimus dorsi*; WBSF, Warner Bratzler shear force; ROS, reactive oxygen species; MDA, malondialdehyde; T-AOC, total antioxidant capacity; GPx4, glutathione peroxidase 4; Nrf2, Nuclear factor-like-2 factor; SOD, superoxide dismutase; IMF, intramuscular fat; BW, body weight; SBW, shrunk body weight; ADG, average daily gain

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Table 1

Nutrient composition of wine grape pomace (air-dry matter basis, %).

Items	%
Dry matter, DM	92.4
Crude protein, CP	11.5
Ether extract, EE	6.5
Crude ash, Ash	8.1
Neutral detergent fiber, NDF	43.8
Acid detergent fiber, ADF	35.1
Calcium	1.2
Phosphorus	0.05
Total phenols, TP	7.2

Lamb production has substantially burgeoned in several parts of the world to meet the needs of increased consumption (Morris, 2009). In China, areas of mutton sheep production are mainly located in the West and Northwest, regions possessing a fragile ecologic system (Zhu et al., 2016). To address the eco-environmental problems, an ecosystem conservation and restoration project was initiated in 2000, which includes the encouragement of pen-raising for sheep. However, this intensive production elevates animal's exposure to oxidative stress conditions (Casamassima et al., 2012).

Based on the data from the International Organization of Vine and Wine (OIV), China is ninth on the list of ten major red wine producing countries, suggesting the possibility to utilize WGP for the lamb industry. Our previous results showed that dietary WGP supplementation in ram lamb alleviated restraint induced oxidative stress in testes and improved epididymal sperm quality (Zhao et al., 2017). Whether animal production performance and meat quality were affected by WGP remains undefined. Thus, the aim of this study was to investigate the effects of dietary WGP supplementation on growth performance, meat quality and antioxidant activity in ram lambs raised in pens.

2. Materials and methods

2.1. Feed preparation

Red wine grape pomace (obtained from a winery) was dried and milled, and nutrient composition of wine grape pomace, dietary ingredients and nutrient level of diets were shown in Tables 1 and 2, respectively, which have been reported in our previous paper (Zhao et al., 2017). The feed was formulated based on the National Research Council's (NRC, 2007) recommendation as a pelleted mixed diet.

2.2. Care and use of animals

All animal procedures were approved by the Shanxi Agricultural University Animal Care and Ethical Committee. A total of

Table 2

Dietary ingredients and nutrient level of diets (air-dry matter basis, %).

Dietary ingredient	Control	5% WGP ^a	10% WGP
Corn, %	29.0	27.0	24.9
Soybean meal%, 44% crude protein	9.0	8.6	8.2
Wheat bran, %	4.0	4.0	4.0
Oil cake of flax seed, %	5.0	5.0	5.0
Mineral/vitamin premix, %	5.0	5.0	5.0
WGP, %	0.0	5.0	10.0
Naked oats straw, %	35.0	34.7	34.3
Potato ratten, %	13.0	10.8	8.6
Total	100.0	100.0	100.0
Nutritional level			
Dry matter (%)	88.4	88.6	88.5
Digestible energy (MJ/kg)	10.6	10.5	10.5
Metabolize energy (MJ/kg)	8.7	8.7	8.6
Crude protein (%)	11.7	11.9	12.2
Ether extract, EE	2.2	3.2	3.4
Neutral detergent fiber (%)	42.9	43.2	43.4
Calcium (%)	0.4	0.4	0.4
Phosphorus (%)	0.25	0.26	0.26
Total phenols, TP (%)	0.41	0.87	1.14

^a Wine Grape pomace.

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