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Oregano, rosemary and vitamin E dietary supplementation in growing rabbits: Effect on growth performance, carcass traits, bone development and meat chemical composition

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ABSTRACT

The study aimed to evaluate the effect of dietary supplementation with different natural additives (aqueous extracts) on the performance of growing rabbits, the nutritional composition and oxidative stability of their meat and on their hind leg bone traits. For this experiment, 200 New Zealand White rabbits weaned at 30 days of age were randomly allocated into five dietary groups ($n=40$ rabbits/group) until 80 days of age, when they were sacrificed. Dietary groups were: S (standard diet with no supplementation), E (standard diet+150 ppm vitamin E positive control), O (standard diet+0.2% oregano, *Origanum vulgare*, aqueous extract), R (standard diet+0.2% rosemary, *Rosmarinus officinalis*, aqueous extract) and OR (standard diet+0.1% oregano extract+0.1% rosemary extract). An additional 50 ppm vitamin E was added to each diet. Rabbits in the O and OR groups showed the highest final live weight and carcass weight ($P<0.001$). Oregano supplemented animals also had the best feed conversion ratio. *Longissimus dorsi* (LD) meat of E and R rabbits had higher protein content compared to O and OR ($P<0.001$) which had a higher moisture content than E rabbits ($P<0.005$). All dietary treatments improved the oxidative stability of the LD meat compared to the S group. Treatments O and E were the most effective in delaying the lipid oxidation of LD meat, followed by the OR and R diets ($P<0.005$). No significant differences among groups in composition of the hind leg meat (HL) were observed. The O rabbits had a higher bone weight ($P<0.05$) than E animals and this difference was mainly ascribable to femur weight ($P<0.01$). In conclusion, the study showed that supplementation with 0.2% oregano can have a positive effect on productive performance and meat quality of rabbits.

1. Introduction

Rabbit meat is a common food in many Mediterranean countries like Algeria, Cyprus, Egypt, France, Italy, Spain, and some other European countries such as Belgium, Czech Republic, Luxembourg and Portugal (Dalle Zotte and Szendrő,

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2011). From the nutritional point of view, rabbit meat is ideal for all kinds of consumers. This is especially useful in Western countries whose diet is generally rich in fats and sodium, exposing them to health problems such as obesity, cardiovascular diseases and hypertension (Karppanen and Mervaala, 2006). Rabbit meat is rich in proteins, B vitamins and minerals but it is low in sodium, fat and cholesterol which makes its energy content (789 kJ/100 g meat, average carcass value) mostly attributable to proteins (Dalle Zotte and Szendrő, 2011). The fact that rabbit meat is particularly rich in unsaturated fatty acids, renders it susceptible to oxidation which can cause loss of nutritive value and worsens meat physical characteristics and sensory quality. In addition, lipid oxidation negatively impacts meat healthfulness as it causes the formation of toxic compounds like malondialdehyde (MDA) and cholesterol oxidation products which have been demonstrated to negatively affect human's health (Wood et al., 2004). For this reason, especially in the past, the meat industry extensively used synthetic antioxidants. However, in the last decade consumer's opinion towards this kind of additives has become more and more negative due to safety issues. This forced the meat industry to take into consideration and test antioxidants coming from natural sources, supplemented to animal's diets (Ao et al., 2011; Dal Bosco et al., 2014) or directly added to the final product (McCarthy et al., 2001; Kanatt et al., 2005; Cullere et al., 2013). In addition to their antioxidant potential, natural sources have been increasingly studied for their effects on the performance of farmed animals, especially after the European ban of growth promoters (1st January 2006) and the increasing restrictions also in the United States (Landy et al., 2011).

Aromatic plants and their essential oils are good sources of natural antioxidants, such as phenolic compounds, *e.g.*, eugenol, thymol, carvacrol (Kahkonen et al., 1999; Franz et al., 2010). Polyphenols generally occur as glycosides, although the bioactivity is attributed to aglycon structures and mainly to catechol in aglycons (Sakakibara et al., 2003). It is thought that the antioxidant activity of these compounds is due to their high redox properties and chemical structure, which is responsible for neutralizing free radicals, chelating transitional metals and quenching singlet and triplet oxygen by delocalization or decomposing peroxides (Rice-Evans, et al., 1995; Zheng and Wang, 2001; Chun et al., 2005). Plant phenols exhibit *in vitro* antioxidant activity, inhibiting lipid peroxidation by acting as chain-breaking peroxyl-radical scavengers (Proestos et al., 2006; Miguel, 2010). Therefore, they can play a protective role for highly unsaturated lipids in feed against oxidative damage (Elgayyar et al., 2001; Miguel, 2010), partly substituting the use of α-tocopheryl acetate or preservatives.

In this context, plants of the *Labiatae* family are among the most widely studied both as antioxidants and as natural substitutes to growth promoting antibiotics in farmed animals. Oregano (*Origanum vulgare*) has attracted great interest as its essential oil is rich in the monoterpenes, thymol and carvacrol, which exhibit good antioxidant and antimicrobial activities *in vitro* and *in vivo*, together with stimulating animal digestion (Ertas et al., 2005; Tomaino et al., 2005). Seydim and Sarikus (2006) testing antimicrobial properties of whey protein isolate films containing different ratios of oregano, rosemary and garlic essential oils, concluded that the oregano essential oil at 2% was the most effective against *Escherichia coli*, *Staphylococcus aureus*, *Salmonella enteritidis*, *Listeria monocytogenes* and *Lactobacillus plantarum*. Soultos et al. (2009) analyzed two diets supplemented with oregano essential oil at levels of 100 and 200 mg/kg diet, observed that rabbit performance parameters were not affected whereas the dietary supplementation resulted in lower average microbial counts on the carcasses, compared to the controls. Similarly, rosemary (*Rosmarinus officinalis*) possesses antioxidant and antimicrobial properties due to its phenolic terpenes, such as rosmarinic acid and rosmarol (Cuppett and Hall, 1998). It is still unclear whether phytogenic antioxidants are effective in replacing the antioxidants usually added to the feeds (Windisch et al., 2007), and, given that phytogenic feed additive research on rabbits is limited, the current study was carried out to evaluate the single and combined effects of oregano, rosemary and α-tocopherol on rabbit performance, mortality and carcass yield. The last was chosen as an effective reference for its antioxidant properties and essential body functions (Ebeid et al., 2013). The single and combined effects of phytogenic antoxidants on rabbit performance, mortality rate, carcass yield, meat chemical composition and oxidative stability were studied.

2. Materials and methods

2.1. Animals and diets

This study was a part of a project supported by Italian Ministry of Economic Development and was carried out in collaboration with important participants in the Italian rabbit production chain.

The trial was carried out at the experimental rabbitry of the Department of Agricultural, Food and Environmental Sciences of the University of Perugia. A total of 200 weaned New Zealand White rabbits of both sexes were used. At weaning (30 days of age), rabbits were randomly allocated to five dietary groups, homogeneous for live weight and gender (40 rabbits/group), and housed in single wire net cages (600 × 250 × 330 mm) until 80 days of age, when they were slaughtered. Dietary groups were:

- Standard diet – with no supplementation (S);
- Standard diet + 150 ppm Vit E – positive control (E);
- Standard diet + 0.2% oregano (*Origanum vulgare*) aqueous extract (O);
- Standard diet + 0.2% rosemary (*Rosmarinus officinalis*) aqueous extract (R);
- Standard diet + 0.1% oregano aqueous extract + 0.1% rosemary aqueous extract (OR).

All diets, provided by provided by Mignini&Petrini (Petrignano di Assisi, Perugia, Italy) were isonitrogenous and isoenergetic and the main ingredients were alfalfa meal, sunflower seed meal, wheat bran, barley and sugar beet pulp. Composition of the diets is shown in Table 1.

The oregano and rosemary extracts were provided by Phenbiox® (Calderara di Reno, Bologna, Italy) after an enzyme-aided extraction from leaves using water as solvent. In particular, dry plants were suspended in water