Animal Feed Science and Technology 239 (2018) 27–32

Contents lists available at ScienceDirect

Animal Feed Science and Technology

journal homepage: www.elsevier.com/locate/anifeedsci

Short communication

Impact of dietary quercetin on laying hen performance, egg quality and yolk oxidative stability

P. Simitzis, D. Spanou, N. Glastra, M. Goliomytis*

Department of Animal Science and Aquaculture, Agricultural University of Athens, 75 Iera Odos, GR11855, Athens, Greece

ARTICLE INFO

Keywords:
Quercetin
Oxidative stability
Cholesterol
Egg quality
Laying hens

ABSTRACT

The objective of the present study was to investigate the effect of the natural flavonoid quercetin dietary supplementation on laying hens' performance, egg quality parameters and yolk oxidative stability. One hundred and ninety two laying hens were allocated into 4 treatment groups: the control (C) group that was fed with a commercial basal diet and the other experimental groups that were offered the same diet further supplemented with quercetin at 200, 400 and 800 mg per kg of feed (Q2, Q4 and Q8 group, respectively) for 28 days. Supplementation with quercetin at 400 mg per kg of feed increased feed intake and eggshell weight in comparison with the groups fed with 200 and 800 mg per kg of feed ($P < 0.05$) but no significant differences were found compared to the controls ($P > 0.05$). Egg yolk cholesterol levels were increased with increased levels of quercetin in hens diet (P, P-linear < 0.05) whereas blood serum cholesterol levels remained unaffected by quercetin treatment (P, P-linear > 0.05). Egg yolk oxidative stability was improved even from the 4th day of supplementation with quercetin (P, P-linear < 0.05). This beneficial effect was also observed in eggs that were stored for up to 90 d (P, P-linear < 0.05). In conclusion, quercetin may favorably prolong shelf-life of eggs, without any side effects on hen performance and egg quality traits.

1. Introduction

The use of polyphenols has recently attracted considerable scientific interest mainly due to their potential beneficial effects in humans and animals. These compounds are mostly investigated for their antioxidant properties but also for their health benefits against chronic inflammation, cardiovascular diseases, cancer and diabetes (Acosta-Estrada et al., 2014), and their ability to improve glucose tolerance, lower plasma lipid levels and control obesity (Nichols et al., 2011). Flavonoids, the most numerous group of polyphenols, have been extensively examined for their beneficial effects on farm animals' productivity and health, mainly because they are natural antioxidants that are safer alternatives to the synthetic ones (Balasundram et al., 2006), and have been indicated as possibly the most beneficial for poultry (Kamboh et al., 2015). The antioxidant activity of flavonoids is attributed to one or more aromatic hydroxyl groups contained in their molecule, which actively scavenge free radicals. They are widely distributed in the plant kingdom as secondary metabolites synthesized for defense against infection and stress conditions, such as ultraviolet light, pathogens and physical damage (Robbins, 2003).

Quercetin (IUPAC name: 2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxy-4H-chromen-4-one) is a phytochemical compound that belongs to the subclass of flavonols and is commonly found in many fruits and vegetables such as apples, onions and their by-products

Abbreviations: FCR, feed conversion ratio; MDA, malondialdehyde; W, width; L, length; N, eggshell breaking strength; L*, lightness; a*, redness; b*, yellowness; C, control; Q2, 200 mg quercetin per kg feed; Q4, 400 mg quercetin per kg feed; Q8, 800 mg quercetin per kg feed

* Corresponding author.
E-mail address: mgolio@aua.gr (M. Goliomytis).

https://doi.org/10.1016/j.anifeedsci.2018.03.004
Received 7 November 2017; Received in revised form 6 March 2018; Accepted 10 March 2018
0377-8401/

like apple skins (Peschel et al., 2006). Quercetin has been demonstrated to be an excellent in vitro antioxidant (Boots et al., 2008) that possess anti-inflammatory properties in mice (Huang et al., 2010) and humans (Sternberg et al., 2008) and antitumor properties in mice (Schlachterman et al., 2008). Research in poultry has been shown that quercetin and its glycosides are absorbed and metabolized when fed to broilers in a similar pattern to mammals (Rupasinghe et al., 2010). Dietary quercetin improves meat oxidative stability in broiler chickens (Goliomytis et al., 2014) and also possesses immunomodulatory properties since it enhances IgY antibody production in broilers (Hager-Theodorides et al., 2014) and IgA antibody production in turkey hens (Ognik et al., 2016). Utilization of quercetin by laying hens improves their antioxidant status (Iskender et al., 2016), reduce yolk (Liu et al., 2013) and serum cholesterol levels (Iskender et al., 2016), and modulates cecal microflora populations (Liu et al., 2014).

However, to our knowledge, no published data is available in the literature describing the effect of dietary quercetin on egg yolk oxidative stability and as a consequence on egg shelf life. The aim of the present study was therefore to evaluate the effects of dietary supplementation with quercetin on egg yolk antioxidant capacity and on performance parameters, cholesterol levels and egg quality characteristics of laying hens.

2. Materials and methods

2.1. Animals and experimental design

A total of 192 Lohmann Brown-Classic laying hens (70 weeks old), from the flock kept in the facilities of the experimental station of Agricultural University of Athens, were randomly allocated into 4 treatment groups. Each treatment group consisted of 6 replicate enriched cages with 8 hens each. One of the groups served as control (C) and was offered a commercial basal diet, whereas the other three groups were fed with the same diet further supplemented with quercetin (MP Biomedicals, LLC, Illkirch, France, 97%) at 200, 400 and 800 mg per kg of feed (Q2, Q4 and Q8 group, respectively) for 28 days. All diets were in mash form in order to uniformly mix quercetin in the basal diet. Table 1 presents the ingredients and the composition of the basal diet. Water was provided ad libitum throughout the experimental period and the light regimen was 16 h of continuous light per day.

Egg production and egg mass were determined on a daily basis whereas feed intake and feed conversion ratio (FCR) were weekly recorded. At the 4th, 7th and 28th day of the experiment, 8 eggs were randomly selected from each treatment group (32 eggs total), with at least one egg from each cage, for egg yolk oxidative stability determination by using the malondialdehyde (MDA) assay. MDA was also measured in 8 eggs per treatment group that were collected at the end of the experiment and were stored for 28 days at room temperature (15–20 °C) and for 90 days at 4 °C. At the 28th day of the experiment 2 eggs were randomly collected from each cage (48

Table 1
Ingredients and chemical composition of the diet used.

Ingredients	g/kg
Maize	577
Soybean meal, 47% CP	248
Wheat bran	48
Soybean oil	14
Limestone	94
Monocalcium phosphate	11
Sodium chloride	2.4
Sodium bicarbonate	2.4
Methionine 99%	1.5
Choline chloride 70%	0.7
Vitamin and Mineral premix[1]	1
Chemical composition	
Metabolizable energy (Mj/kg)[2]	11.47
Crude protein	166
Fiber	25
Fat	30
Ash	129
Lysine[2]	9
Methionine + cystine[2]	7.3
Calcium[2]	38
Available phosphorus[2]	4

[1] The vitamin and mineral premix provided per kg of diet: 12,500 IU of vitamin A, 3000 IU of vitamin D3, 32 mg of vitamin E, 5 mg of vitamin K3, 1.8 mg of vitamin B1, 6.25 mg of vitamin B2, 3.75 mg of vitamin B6, 25 μg of vitamin B12, 44 mg of nicotinic acid, 12.5 mg of pantothenic acid, 1 mg of folic acid, 75 μg of biotin, 13 mg of vitamin C, 450 mg of choline chloride, 1.8 mg of I, 0.36 mg of Se, 60 mg of Fe, 125 mg of Mn, 10 mg of Cu, 100 mg of Zn and 300 FTU of phytase and 4 mg of canthaxanthin.

[2] calculated.