Omega-3 Enrichment of Quail Eggs: Age, Fish Oil, and Savory Essential Oil

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ABSTRACT

The aim of this study was to develop a diet suitable for obtaining quail eggs enriched with omega-3 fatty acids with minimum disadvantages on egg quality. This 12 weeks study was performed to investigate the effects of Fish Oil (FO) and Savory (Satureja khuzestanica) Essential Oil (EO) supplementation in diets of laying quails at different ages, on their performance, egg quality, fatty acid composition, and oxidation of egg yolk. One hundred and ninety-two Japanese quails were allocated to 8 groups (24 birds in each) with four replicates (having 6 birds in each) in a factorial arrangement with 3 variables: Age (31 and 12 weeks), FO (0 and 15 g kg⁻¹), and EO (0 and 500 mg kg⁻¹). The results showed that FO supplementation partially improved feed conversion ratio, hen-day egg production, egg weight and egg mass. There were no significant differences in albumen and shell weight percentage, but yolk percentage was significantly lower in FO groups. Savory essential oil significantly decreased shell thickness (P< 0.05). Percentage of yolk eicosapentaenoic Acid (EPA) and docosahexaenoic Acid (DHA) increased but Arachidonic Acid (AA) percentage and the ratio of n-6/n-3 fatty acids decreased in the eggs of the birds fed on diets supplemented with FO. Also EO supplementation decreased omega-3 enriched egg yolk lipids oxidation during refrigeration and room temperature preservation. Thus, it is possible to produce quail's n-3 enriched eggs, which can improve public health and be used for marketing purposes without any loss in eggs quality through dietary administration of FO and EO.

Keywords: Dietary administration, Herbal antioxidant, Quail n-3 enriched eggs, Performance, Yolk oxidative stability.

INTRODUCTION

High intakes of long-chain n-3 polyunsaturated fatty acids are associated with a decreased risk of cardiovascular disease (Rymer et al., 2010). Long-chain polyunsaturated fatty acids, Docosahexaenoic Acid (22:6 n-3, DHA) is important for biological membranes, the retina, the cerebral cortex, nervous tissues, the testicles, blood platelets, and EPA for its effect on arteries (antithrombotic and anti-inflammatory) resulting from the metabolism of eicosanoids (biological molecules that act as signals and messengers) (Arantes da Silva et al., 2009; Shimizu et al., 2001).

The proportional concentration of these fatty acids in poultry egg is affected by many factors including age, genetics, ration, and season. Research revealed that the content of myristic, palmitic, palmitoleic, stearic, and linoleic acids of yolk decreased with increasing age of layer hen (Yilmaz-Dikmen and Sahan, 2009). Latour et al. (1998) demonstrated that palmitic and stearic acid contents were greater in the yolks of eggs from hens at 51 and 64 weeks than in eggs from hens at 36 week.

Consumer awareness of the health benefits of n-3 fatty acids is growing and is driving

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consumer demand for enriched food products (Zuidhof et al., 2009). All vegetable fat sources seem to be less effective than marine fats when meat is enriched with polyunsaturated Fatty Acids (PUFA, particularly with n-3 long-chain fatty acids (C≥ 20)). This effect results from the content of n-3 fatty acids, because marine oils contain EPA and DHA, whereas vegetable oils contain greater levels of linolenic acids (LNA), whose conversion to longer-chain derivatives and deposition in peripheral tissues is not sufficient to give nutritionally valuable modified products (Lopez-Ferrer et al., 2001). However, Petrovic et al. (2012) reported the increase of C18:3 n-3 and C22:6 n-3 in eggs by supplementation of linseed oil (1-4%) to hens’ feed.

In regular eggs, the n-6/n-3 ratio varies from 1:15 to 1:20, which is far from human nutritionist’s recommendations of 4:1 to 6:1 (Kazmierska et al., 2007). It is feasible to modify this ratio easily by feeding strategies such as providing hens with n-3 fatty acids enriched diets. Also, Kazmierska et al. (2005) reported that layer quails were more efficient in production of n-3 enriched eggs than layer chicken.

Although fish is considered to be the primary source of n-3 PUFA, it may not serve as a primary source for people (Lewis et al., 2000b). It has been proved that n-3 fatty acids are essential for normal growth and development and may play an important role in the prevention and treatment of coronary artery diseases, hypertension, diabetes, arthritis, other inflammatory and autoimmune disorders, and cancer (Lewis et al., 2000a; Simopoulos, 1991; Simopoulos et al., 1991). The n-6 and n-3 fatty acids are the parent fatty acids for the production of eicosanoids, e.g., prostaglandins, thromboxanes, and leukotrienes. Also, eicosanoids derived from n-6 fatty acids have opposite metabolic properties to those derived from n-3 fatty acids (Simopoulos, 2000).

Lipid oxidation during food processing and storage is of major importance. Oxidation of polyunsaturated lipids results in hydroperoxides which are susceptible to further oxidation or decomposition to secondary reaction products such as short-chain aldehydes, ketones, and other oxygenated compounds that may adversely affect flavor, taste, nutritional value, and overall quality of foods (Vercellotti et al., 1992). Since most egg lipids are located in the yolk, they are susceptible to oxidation and thus require quality control (Aghdam Shahryar et al., 2010). Also, oxidation is influenced by dietary factors such as fat composition and storage times (Rahimi et al., 2011).

Therefore, adding antioxidants into poultry diets seems to be an efficient means to improve oxidative stability of eggs as reflected by decreased egg yolk malondialdehyde (MDA) levels. There is an inverse relationship between malondialdehyde concentration and dietary antioxidant level in poultry products (Akdemir et al., 2009). The most commonly used synthetic antioxidants, butylated hydroxyanisole and butylated hydroxytoluene, have been restricted recently, mainly because of their potential carcinogenicity causing liver swelling and changing liver enzyme activities (Rajani et al., 2011).

Also, Orhan and Eren (2011) reported that addition of herbal mixtures to FO layer diets instead of synthetic antioxidants can be a natural method to prevent egg yolk from oxidation.

This experiment was carried out to study the relationship between age, Fish Oil (FO), and Essential Oil (EO) on production parameters, egg quality, yolk fatty acid profiles, and oxidative stability of egg yolk in Japanese quail eggs.

**MATERIALS AND METHODS**

One hundred and ninety-two Japanese quail (Coturnix coturnix japonica) were randomly divided into 8 groups (24 birds in each) with four replicates (having 6 birds in each) in a factorial arrangement, with 3 variables: age (31 and 12 weeks), FO (0 and