INCORPORATION OF VITAMIN E INTO N-3 POLYUNSATURATED FATTY ACIDS ENRICHED DUCK EGGS[1]

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ABSTRACT

The objective of this experiment was to determine the effects of n-3 polyunsaturated fatty acids (n-3 PUFAs) enriched diet supplemented with α-tocopheryl acetate on the contents of α-tocopherol and n-3 PUFAs in liver, plasma and egg yolk, and on the lipid stability of yolk in laying Tsaiya ducks. A total of 180 30-wk-old laying Tsaiya ducks, at the beginning of peak production, were allotted into 6 treatments with 3 replicates each. Ducks were fed one of the 6 experimental diets, containing 4% tallow (control), and 4% fish oil supplemented with graded levels of α-tocopheryl acetate at 0, 100, 200, 300, and 400 mg/kg, respectively for 6 wks. Feed and water were supplied *ad libitum* throughout the experimental period. The results indicated that the higher the α-tocopheryl acetate supplementation, the greater the α-tocopherol in the liver, plasma and egg yolks. Yolk EPA, DHA and total n-3 PUFAs contents were linearly ($P < 0.01$) increased with increased dietary α-tocopheryl acetate supplementation. N-3 PUFAs -enriched diet supplementing with α-tocopheryl acetate may improve the stability of lipid peroxidation of fresh eggs.

KEY WORDS : Tsaiya duck, n-3 PUFAs, α-Tocopheryl acetate.

INTRODUCTION

The beneficial effects of the n-3 polyunsaturated fatty acids (n-3 PUFAs), mainly eicosapentaenoic acid (C20:5n-3, EPA) and docosahexaenoic acid (C22:6n-3, DHA), which are abundant in the fish oil, have been demonstrated by numerous reports (for a review see Leskanich and Noble, 1997), largely as a result of their modulating effects in disease states such as rheumatoid arthritis, systemic erythematous lupus, multiple sclerosis (BNF, 1992), and in reducing the risk of coronary heart disease (Kormhout et al., 1985; Herold and Kinsella, 1986). The n-3 PUFAs have been shown to have health promoting benefits in humans (Illingworth and Ullmann, 1990). Dietary fish oil inclusion resulted in significant increase in the n-3 PUFAs, in particular, the EPA and DHA contents in shell eggs (Hargis et al., 1991; Hargis and Van Elswyk, 1993; Chen and Hsu, 2003). In a previous study, we demonstrated that n-3 PUFAs-enriched duck egg can be produced by supplementation with 4% refined cod liver oil (RCLO) to the duck diet without affecting the laying performance and organoleptic evaluation (Chen and Hsu, 2003). However, fish oils are highly unsaturated and susceptible to peroxidation when excessive consumption without added sufficient antioxidants (Fritche and

Johnston, 1988; Qi and Sim, 1998). Tocopherol, which has vitamin E activity, has been extensively used in foods as a natural antioxidant (Bauernfeind, 1997). Thus, incorporating tocopherol into poultry products would increase oxidative stability (Lin *et al*., 1989). Therefore, we conducted this experiment to determine the effects of n-3 PUFAs-enriched diet supplemented with α-tocopheryl acetate on the contents of α-tocopherol and n-3 PUFAs in liver, plasma and egg yolk, and on the lipid stability of yolk in laying Tsaiya ducks.

MATERIALS AND METHODS

Animals and diets

A total of 180 30-wk-old laying Tsaiya ducks, at the beginning of peak production, were allotted into 6 treatments with 3 replicates each. Ducks were fed one of the 6 experimental diets, containing 4% tallow (control), and 4% fish oil (refined cod liver oil) supplemented with graded levels of α-tocopheryl acetate at 0, 100, 200, 300, and 400 mg/kg, respectively for 6 wks. All of the experimental diets were formulated to be both isocaloric and isonitrogenous and analyzed for proximate constituents according to standard procedure (AOAC, 1984). Ducks were housed in individual cages (25 × 30 × 39 cm). Feed and water were supplied *ad libitum* during the experimental period.

General and analytical procedures

At the beginning and the end of the experimental period, all ducks were weighed individually. Feed consumption was recorded biweekly, and eggs were collected and weighed daily throughout the experimental period. On the 7th day of each week, the collected eggs were weighed and four yolks per replicate were separated from albumin, weighed, pooled, and blended. On the last day of the experiment, blood samples were taken from the wing vein of 6 ducks form each treatment. Plasma were later separated from each blood sample and then stored at –20℃ pending analysis of n-3 PUFAs and α-tocopherol. The ducks were subsequently decapitated, and the liver were immediately removed and weighed for the analysis of n-3 PUFAs and α-tocopherol. The n-3 PUFAs and α-tocopherol in diets, livers, plasma and pooled yolks were determined by the method of Chen and Hsu (2003, 2004). Fresh duck eggs were stored at 4℃ for 3 wks, the TBA value of egg yolks were analyzed at each week by the methods of Faustman *et al*. (1992).

Statistical analysis

All data were analyzed by using the General Linear Model Procedures of SAS (SAS, 1988). Comparison of treatment means was based on a Duncan's multiple range test. A significance level of $P < 0.05$ was applied in all cases.

RESULTS AND DISCUSSION

The mainly and nutritionally important compositions of n-3 and n-6 PUFAs in the experimental diets were altered by dietary fat sources used in the diets. The linoleic acid (C18: 2n-6) content was higher in the tallow diet than that in the fish oil diet. In contrast, the fish oil diet contained higher levels of α-linolenic acid (C18: 3n-3), eicosapentaenoic acid (EPA, C20: 5n-3), docosahexaenoic acid (DHA, C22: 6n-3) and total n-3 PUFAs as compared to the

tallow diet.

The higher the α-tocopheryl acetate supplementation, the greater the α-tocopherol in the liver, plasma and egg yolks. The yolk α-tocopherol content was significantly higher ($P < 0.05$) in α-tocopheryl acetate supplementation treatments than in the control and 4%FO treatments. The results are consistent with the findings of Jiang *et al*. (1994) and Meluzzi *et al*. (2000) who indicated that the yolk α-tocopherol contents increased with increasing dietary α-tocopheryl acetate supplementation in laying hen diet.

Ducks fed on α-tocopheryl acetate supplemented diets had higher n-3 PUFAs in the yolk compared to the control and 4% FO treatments. This indicated that α-tocopherol supplementation to duck diets results in increased α-tocopherol content in yolk and liver and a concomitant increase in the stability of the n-3 PUFAs in yolks. Supplementation with α-tocopheryl acetate improved the stability of the yolk, with stability increased as yolk α-tocopherol increased. The experiment result showed that n-3 PUFAs and vitamin E enriched duck eggs can be produced by supplementation with 4% fish oil and 400 mg α-tocopheryl acetate/kg to the duck diets. These eggs may serve as viable dietary alternatives to fish, fish products or hen eggs to provide significant amounts of n-3 PUFAs and vitamin E in our daily diet.

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