Effects of increases in vitamin C supplementation in the laying hen rations on serum concentrations of vitamin C and vitamin A

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SUMMARY

This study was carried out to determine the effects of layer rations containing 0, 50, 100 and 200 mg/kg vitamin C on vitamin C and vitamin A concentrations in serum of hens. A total of 96 commercial hens (28 weeks of age) were used in present experiments. There were a control and three treatment groups, each containing 24 hens. The experimental period lasted 10 weeks. Serum vitamin C and vitamin A concentrations were determined three times at 30, 34 and 38 weeks of ages.

Serum vitamin C and vitamin A concentrations increased with increasing amounts of vitamin C in rations. During the experiment, serum vitamin C concentration was increased significantly (p < 0.05) by the addition of 200 mg/kg vitamin C, and serum vitamin A concentration was increased significantly in all groups (p < 0.05). It has been concluded that vitamin C protected vitamin A against oxidation and increased serum vitamin A levels in parallel with increased serum vitamin C.

KEY-WORDS : food - vitamin C - vitamin A - poultry.

RéSUMÉ

Effets d’un apport croissant de vitamine C dans les rations de poules pondeuses sur les concentrations sérigraphes de vitamine C et de vitamine A. Par A.A.YIGIT, T. DIKICIOGLU et G. YARIM.

Le but de cette étude est de rechercher les effets d’une supplémentation en vitamine C dans les rations des poules pondeuses sur les concentrations sérigraphes de vitamines C et A.

Quatre-vingt seize poules pondeuses hybrides, de type commercial, âgées de 28 semaines ont été réparties en 4 lots, chacun contenant 24 animaux, en fonction de la quantité de vitamine C ajoutée à la ration (lot 1 (contrôle) : 0 mg/kg, lots 2 à 4 : 50, 100 et 200 mg/kg). La durée de l’expérience a été de 10 semaines. Les concentrations sérigraphes de vitamines C et A ont été déterminées 3 fois à 4 semaines d’intervalle.

Plus la quantité de vitamine C apportée à la ration a été élevée, plus les concentrations sérigraphes de vitamines C et A ont augmenté. Les variations des concentrations sérigraphes de vitamine C ont été statistiquement significatives dans le groupe recevant 200 mg/kg d’ascorbate (lot 4) (p < 0.05). Dans tous les groupes supplémentés, on a observé des augmentations significatives des concentrations sérigraphes de vitamine A (p < 0.05).

En conclusion, d’une part, un apport alimentaire en vitamine C entraine à la fois et de façon corrélée une augmentation des concentrations sérigraphes en vitamines C et A, et d’autre part, la vitamine C préviendrait l’oxydation de la vitamine A.

MOTS-CLÉS : alimentation - vitamin C - vitamin A - poule.

Introduction

Avian species have the inherent ability to synthesize vitamin C [24], therefore, this vitamin is not required in poultry diets under normal conditions. The most significant increase in ascorbic acid demand take place during acute environmental stress such as excessive hot or cold weather [4], and under stress conditions that increase the metabolic need for this vitamin or that decrease the innate capacity of biosynthesis [6]. Under such conditions, supplementing the poultry diet with vitamin C may have a beneficial effect on performance [9, 35, 47]. Several investigators reported improvement in shell quality [6, 11, 28], albumen quality [7, 8, 31], egg weight [11, 37], egg production [17, 23] and livability [8, 37] due to supplementing the hen’s diet with vitamin C under elevated environmental temperatures. In addition, some studies reported that blood [2, 10, 12, 32, 49] and yolk cholesterol [2, 12, 43, 49] were significantly decreased by the addition of vitamin C to the rations.

Although in man, ascorbic acid absorption is dependent on an active transport mechanism [20], the chicken ascorbic acid absorption is a Na dependent passive transport process.
Vitamin A deficiency may be a problem unless precautions are taken [3, 29, 40].

There are inconsistent reports on the correlation with vitamin A and vitamin C [1, 5, 43, 44]. Some reports indicated that vitamin A depletion causes drop in plasma vitamin C concentrations [25, 26]. NOCKELS et al. [33] also found that vitamin A deficiency reduces circulating levels of ascorbic acid, although RUBIN and BIRD [39] reported that vitamin A deficiency in mature chickens did not interfere with ascorbic acid synthesis. Vitamin A deficient rats have been reported to have decreased ascorbic acid synthesis [30]. Also vitamin A protects vitamin C against oxidation [26]. Vitamin C is a chain breaking antioxidant [42], which helps to protect fats and liposoluble vitamins, particularly vitamin A, from rancidity and degradation [36].

Numerous studies have been established with respect to the effects of large amount of vitamin C in animals [56]. As intestinal absorption declined with increasing ascorbic acid dosage, renal excretion of ascorbic acid initiated as intestinal absorption declined with increasing ascorbic acid dosage [10, 18, 21, 30, 34]. PARDOE et al. [34] reported that plasma ascorbic acid concentrations were significantly elevated in chicks receiving 100 ppm ascorbic acid or greater. Also it would appear from this study that plasma saturation does not occur when chicks are fed a diet containing 2000 ppm ascorbic acid. FARR et al. [13] conducted three trials to determine if the addition of high levels of ascorbic acid (0, 600, 1200 ppm), in the drinking water of broilers increased serum vitamin C concentration according to increasing amounts of vitamin C in rations (16.9, 21.0, and 23.0 ppm respectively). Earlier ascorbic acid loading studies in the chicken that consumed diets containing 2600 and 3600 ppm ascorbic acid were determined 28.1 and 33.4 µg/ml respectively [10, 18].

### Materials and methods

A trial was conducted with 96 female 28 week old commercial laying hens housed in individual wire cages. The experimental period lasted 10 weeks. The hens were fed a commercial diet for two weeks for adaptation and then were divided into four groups each containing 24 hens. Each of the four diets contained 0, 50, 100 or 200 mg/kg vitamin C respectively. During the experiment, feed and water were provided for ad libitum consumption. The birds exposed to 17 h of light/d.

At the 30, 34 and 38 weeks age, blood samples were taken from wing vein. Serum samples were obtained immediately and analyzed for vitamin C and vitamin A concentration. Serum vitamin C and vitamin A concentration was determined spectrophotometrically [27, 45].

Data obtained from all experiments were evaluated for significance of treatment means using one-way ANOVA procedure of Statistical Package for the Social Sciences (SPSS). Means were compared by Duncan’s multiple comparisons range test (p < 0.05). Effect of vitamin C supplementation in ration on vitamin A concentration was assessed by using covariance analysis.

### Results and discussion

Variations of the serum concentrations of vitamin C and vitamin A according to the duration of the supplementation and according to the ascorbate amount in ration are reported in table I and figure 1 respectively. Correlation between vitamin C and vitamin A concentrations in total collected samples are reported in figure 2.

In the present study, it was observed that both serum vitamin C and vitamin A concentrations increased in parallel with vitamin C supplementation to the feed (p < 0.05). Plasma ascorbic acid concentrations have generally been shown to correlate with dietary ascorbic acid intake [41]. But intestinal absorption declined and renal excretion exceeded with increasing ascorbic acid dosage [10, 18, 21, 30, 34]. PARDOE et al. [34] reported that plasma ascorbic acid concentrations were significantly elevated in chicks receiving 100 ppm ascorbic acid or greater. Also it would appear from this study that plasma saturation does not occur when chicks are fed a diet containing 2000 ppm ascorbic acid. WILSON [48] suggested that while plasma ascorbic acid levels may change precipitously, tissue uptake may be limited by a «protective» mechanism that prevents excessive and potentially detrimental cellular concentrations of ascorbic acid. As shown in table I, serum vitamin C concentration was increased in all treatment groups during the supplementation.
but this increase was significant (p < 0.05) only in the group supplemented with 200 mg/kg vitamin C. Vitamin A concentration was also increased in parallel with supplementation period as pointed in figure 1 (p < 0.05). It would appear from this study that plasma saturation in vitamin A concentrations does not occur when chicks are fed a diet containing 50, 100 and 200 mg/kg ascorbic acid.

Vitamin C caused an increase in serum vitamin A concentration in parallel with increases in serum vitamin C concentrations. High correlations (p < 0.05) between vitamin C and vitamin A were found in control and treatment groups at the week 30, 34 and 38 (r = 0.88, 0.81 and 0.92 respectively). Early studies indicated that ascorbic acid protects lipids from oxidation [14, 15] and therefore fat soluble vitamin A from destruction against peroxidative damage [36]. Increase in
serum retinol concentration might be attributed to the delaying effect of ascorbic acid on retinol degradation.

Ascorbic acid supplementation has a positive effect on improvement in shell quality [6, 16, 28], albumen quality [7, 8, 31], egg weight [16, 37] and egg production [17, 23] under elevated environmental temperature. It would appear that ascorbic acid supplementation via diet is an effective means to elevate serum ascorbic acid prior to the onset of environmental stressors. It is concluded that such elevations of serum concentrations of vitamin A in parallel to serum vitamin C, which are antioxidant vitamins, are beneficial for hens. It remains to determine if ascorbate supplementation in chickens exposed to stressful conditions which cause major economical in poultry industry, would induce increases in serum vitamin concentrations and therefore improve economical performances.

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