Egg and serum cholesterol concentrations and zootechnical performances of layer hens fed with various levels of Niacin*

F. KURTOGLU1*, V. KURTOGLU2 and M. NIZAMLIOGLU1

Departments of Biochemistry, 1, Animal Nutrition and Nutritional Diseases 2, University of Selçuk, Faculty of Veterinary Medicine, Konya-Turkey.

*Correspondence to: Dr. Firuze Kurtoglu, Department of Biochemistry, University of Selçuk, Faculty of Veterinary Medicine, 42075 Kampüs, Konya-Turkey.
E-mail: kurtoglu@selcuk.edu.tr

* This study is a part of the research project funded by "Research Foundation of Selçuk University" (SÜAF), Project no: SÜAF-VF-2001/063.

SUMMARY

In the present study, the effects of dietary supplementation of niacin on daily feed consumption, body weight, food conversion ratio, egg production, egg weight, specific gravity, serum and egg yolk cholesterol and serum triglyceride concentrations were investigated in layer hens.

A total of 490 27-week-old Brown-Nick layers was divided at random into 7 groups (of 70 hens) fed with diets containing 0, 50, 100, 150, 200, 250 and 300 ppm niacin for 90 days. Niacin supplementation have resulted in decreasing egg yolk, serum cholesterol and triglyceride concentrations (P<0.001). No significant difference between the controls and all the treated groups on damaged egg ratio and body weight was obtained but egg production, food intake, feed conversion ratio, and specific gravity values were affected by niacin treatment on some periods of the experiment (P<0.05).

As a conclusion, dietary niacin supplementation markedly depressed lipid metabolism and particularly cholesterol metabolism and improved some zootechnical performances without deleterious side effect. The identification of biochemical pathways affected by niacin requires further investigations.

KEY-WORDS: niacin - cholesterol - triglyceride - egg - performance - layers.

RéSUMÉ

Concentrations de cholestérol dans l’œuf et le sérum et performances zootechniques des poules pondeuses supplémentées par différentes quantités de niacine dans l’alimentation. Par K. KURTOGLU, V. KURTOGLU et M. NIZAMLIOGLU.

Au cours de cette étude, les effets d’une supplémentation alimentaire en niacine sur la consommation quotidienne d’aliments, l’efficacité de la ration, le poids corporel, la production d’œufs, le poids des œufs, leur densité ainsi que sur la concentration de cholestérol dans l’œuf, la cholestérolémie et la triglycéridémie ont été recherchés chez les poules pondeuses.

Au total, 490 poules Brown Nick âgées de 27 semaines ont été réparties aléatoirement en 7 groupes de 70 oiseaux chacun et nourries pendant 90 jours avec des rations contenant 0, 50, 100, 150, 200, 250 ou 300 ppm de niacine.

La supplémentation en niacine a conduit à une diminution de la teneur de cholestérol dans l’œuf ainsi que des concentrations sériques de cholestérol et de triglycérides (P<0.001). Ni la proportion d’œufs endommagés et ni le poids corporel n’ont présenté de différence significative entre les contrôles et les animaux traités. En revanche, la production en œufs, leur densité, la consommation d’aliments et l’efficacité de la ration ont été affectées (P<0.05) sur différentes périodes expérimentales par l’ajout de la niacine dans l’alimentation.

En conclusion, la supplémentation alimentaire en niacine a nettement diminué le métabolisme lipidique, en particulier celui du cholestérol, et a amélioré certaines performances zootechniques sans induire d’effets délétères. Les mécanismes moléculaires d’action de la niacine restent néanmoins à élucider.


Introduction

Cholesterol metabolism in the laying hen has been studied by determining the effect of dietary factors on the concentrations of blood and egg cholesterol. In most animals, cholesterol is eliminated by catabolism and excretion in the feces as biliary acids, but hens eliminate considerable amounts of cholesterol in the egg [4]. Also, ANDREWS et al., [4] showed that egg cholesterol originates from serum cholesterol. But, other reporters [29, 33, 34] indicated that the plasma cholesterol concentration is not closely associated with the concentration of yolk cholesterol.

Niacin is known to be required as a dietary factor affected the blood and egg yolk cholesterol concentrations of laying hen [35]. But, reports on the response of the laying hen to dietary niacin are scarce [17]. The effects of niacin on serum cholesterol concentrations were reported by some researchers in several animal species. The use of niacin treatment for hypercholesterolemia was reported by ALTSCHUL et al., [2] and ALTSCHUL and HOFFER [3], and they observed a significant decrease of serum cholesterol in man received niacin supplementation. MERRILL and LEMLEY-STONE [20] demonstrated that niacin was capable of protecting rabbits against hypercholesterolemia and atherosclerosis. Other workers [11] have administrated niacin to man and observed significant decreases in serum cholesterol.

Revue Méd. Vét., 2004, 155, 7, 393-400
Niacin supplementation must be considered particularly in poultry diets. Niacin in common feeds is mainly in a bound form which is not available for animals [14]. In formulating poultry diets, some feeds such as corn provide no available niacin for chicks [9]. High niacin amounts are mainly recommended when stress and high production rates are present [7]. For poultry, recommended amounts are generally 12-25% higher than the NRC recommendations. Sources of niacin for laying hens are firstly the niacin content of feedstuffs and also the niacin issued from the metabolic conversion of the alimentary tryptophan and quinolinic acid [37]. Niacin is synthesised by the microflora in some species, but this conversion is negligible in the poultry [10, 21]. Niacin is essentially used in metabolism through coenzyme formation: NAD and NADP [10, 17]. These coenzymes are involved in transfers of hydrogen, which frequently occur in the synthesis and degradation of fatty acids, carbohydrates and amino acids [21]. A decrease in the availability of NAD and NADP coenzymes will depress growth, feed consumption, feed utilisation, egg production and hatchability efficiency. For instance, the Leghorn hens require a minimum of 0.8 mg of niacin per hen per day for egg production and 1.0 mg per hen per day for hatchability [28]. Also, deficiency in niacin may cause fatty liver. In three experiments with laying hens, in which niacin was supplemented up to 100 mg/kg feed, it was found that supplementation of 20 and 50 mg niacin reduced the fat infiltration in the hen livers [14].

The purpose of the present study was to determine effects of various amounts of niacin supplementation to layer hen diets on serum cholesterol, triglyceride, egg yolk cholesterol concentrations and conventional performance characteristics. Since there are only few data reported a relationship between niacin and cholesterol metabolism in the animal species and humans, an attempt was made to evaluate the serum and egg yolk cholesterol in poultry.

Materials And Methods

ANIMALS

A total of 490, 27-week-old Brown-Nick layer hybrids were used. These animals were placed in cage system under fluorescent lighting in Konya Animal Research Institute poultry units.

EXPERIMENTAL DESIGN

The animals were randomly divided into seven groups. To limit the position differences, these groups were divided into seven subgroups consisting of 10 chicks in each group (7 replicates of 10 layers making a group). The subgroups were distributed randomly among the different compartments of the cage system. Each subgroup consisted of 2 cages, which dimentions were 55x45x40 cm in which five hens were placed. The distribution was resulted in 98 cages and 490 laying hens. Experimental period was 90 days.

DIET AND NIACIN

Crude protein, dry matter, ash, crude fibre, lipid content of the experimental diet were determined by chemical analysis [5].

The composition of the basal diet was shown in Table I. Analysis of basal diet was presented in Table II. The basal diet was supplemented with 0, 50, 100, 150, 200, 250 and 300 mg/kg niacin and prepared by using a food mixer. In the pre-experimental period (14 days), dietary niacin supplementation was not realised.

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>g/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>550.0</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>370.0</td>
</tr>
<tr>
<td>Wheat</td>
<td>250.0</td>
</tr>
<tr>
<td>Cottonseed meal</td>
<td>0.5</td>
</tr>
<tr>
<td>Meal-Bone meal</td>
<td>16.0</td>
</tr>
<tr>
<td>Vegetable Gm</td>
<td>31.5</td>
</tr>
<tr>
<td>Lithostroil</td>
<td>98.9</td>
</tr>
<tr>
<td>Di Calcium Phosphorous (DKP)</td>
<td>11.6</td>
</tr>
<tr>
<td>Salt</td>
<td>3.1</td>
</tr>
<tr>
<td>Methionine</td>
<td>1.3</td>
</tr>
<tr>
<td>Vitamin premix</td>
<td>2.5</td>
</tr>
<tr>
<td>Mineral premix</td>
<td>1.0</td>
</tr>
</tbody>
</table>

1 Per 2.5 kg of vitamin premix contains: 3.6 mg vitamin A, 0.05 mg vitamin D3, 30.0 mg vitamin E, 3.0 mg vitamin K3, 3.0 mg vitamin B1, 6.0 mg vitamin B2, 5.0 mg vitamin B6, 0.015 mg vitamin B12, 25.0 mg niacin, 0.04 mg menadione, 8.0 mg carotenoids, 1.0 mg folic acid, 300.0 mg choline chloride, 50.0 mg vitamin C.

2 Per 1 kg of mineral premix contains: 80.0 mg Mn, 35.0 mg Fe, 50.0 mg Zn, 5.0 mg Cu, 2.0 mg I, 0.4 mg Co, 0.15 mg Se.

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>g/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metabolic Energy (Mcal/kg)</td>
<td>11.52</td>
</tr>
<tr>
<td>Crude protein (g/kg)</td>
<td>166.8</td>
</tr>
<tr>
<td>Dry matter (g/kg)</td>
<td>919.7</td>
</tr>
<tr>
<td>Ash (g/kg)</td>
<td>91.0</td>
</tr>
<tr>
<td>Crude fibre (g/kg)</td>
<td>65.6</td>
</tr>
<tr>
<td>Ether extract (g/kg)</td>
<td>35.4</td>
</tr>
<tr>
<td>Calcium (g/kg)</td>
<td>37.0</td>
</tr>
<tr>
<td>Phosphorus (g/kg)</td>
<td>6.5</td>
</tr>
<tr>
<td>Methionine + cystine (g/kg)</td>
<td>6.8</td>
</tr>
<tr>
<td>lysine (g/kg)</td>
<td>3.3</td>
</tr>
</tbody>
</table>

Table I: Composition of the basal diets.

Table II: Chemical analysis of the basal diets.

SERUM CHOLESTEROL AND TRIGLYCERIDE CONCENTRATIONS

For determination of serum cholesterol and triglyceride concentrations, blood samples were taken from 7 chicks in each group by cardiac puncture on the 30th, 60th and 90th days.
Obtained blood samples were immediately centrifuged (Megafuge 1.0 R HERAEUS Sepatech GmbH) at 1000 g for 15 min at +4 °C. Cholesterol and triglyceride analysis were made in these serum samples by a Spectrophotometer (Shimadzu, UV 2100, JAPAN) using a commercial kit (DiaSys Diagnostic Systems GmbH, GERMANY).

**EGG CHOLESTEROL CONCENTRATIONS**

A total of 35 eggs (5 eggs from each subgroup) from each experimental group was randomly taken on the days of 30, 60 and 90 for egg yolk cholesterol analyses. These eggs were hard cooked for 15 minutes. The yolks were separated, weighed and crumbled. Exactly 0.20 g of yolk from each of the five samples of a same subgroup was pooled (1 g total yolk) and extracted by the method of WASBURN and NIX [34]. These yolk extracts were analysed for cholesterol content by the spectrophotometric method of ZLATKIS et al., [39].

**PERFORMANCE CHARACTERISTICS**

The hen-day egg production was first recorded for two weeks during pre-experimental period to check if egg production was similar in groups before niacin supplementation. Then, the hen-day egg production were recorded daily at the same time and calculated as total number of eggs collected divided by total number of live hens per day in each group. The collected eggs were classified as «normal» or «damaged»: broken eggs (an egg with broken shell and destroyed membrane), cracked eggs (an egg with broken shell but intact membrane), or shell-less eggs (an egg without shell but with intact membrane). Egg weight and specific gravity were determined monthly using the methods described by HAMILTON [12] and HEMPE et al., [15]. Animals were provided with ad libitum feed and water throughout the 90-day experimental period. Food consumption (FC) and food conversion ratio (FCR) were determined at 14 day intervals.

**STATISTICAL ANALYSIS**

One-way analyses of variance were conducted for egg yields, egg weights, FC, FCR, damaged egg ratio, specific gravity, body weight, egg yolk weights, egg yolk and total egg yolk cholesterol, serum cholesterol and serum triglyceride concentrations. Any significant differences were further analysed by Duncan’s multiple range test [30]. The differences were considered as significant when p value was less than 0.05.

**Results**

Dietary niacin supplementation induced significant decreases of egg yolk cholesterol concentrations since the 30th day of treatment (P<0.001), whatever the niacin contents in the diets (Table III). The effects persisted until the 60th day of treatment in all supplemented groups (P<0.001), and until the 90th day when dietary niacin content was above 100 ppm (P<0.001). Moreover, a dose-effect relationship between dietary niacin contents and egg yolk cholesterol concentrations was obtained in 60-90 day period: the lowest concentration (8.94 mg/g yolk) was observed in group received 300 ppm of niacin, and the highest concentration (15.69 mg/g yolk) was observed in control group, whereas intermediate concentrations were evidenced in the other supplemented groups (figure 1). Besides, total egg yolk cholesterol content was also significantly affected by niacin supplementation (P<0.001) and varied in the different groups in the same way than egg yolk cholesterol concentrations. A dose effect relationship between dietary niacin contents and this parameter was also obtained (P<0.001). As niacin had no effect on egg
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Yolk weight, the significant variations of total egg yolk cholesterol content could only be related to niacin contents in diets.

In our study, serum cholesterol concentrations were measured. When niacin was added to diets, serum cholesterol concentrations (Table III) decreased but these variations were not statistically significant at the 30th and the 60th days of experiment. But, at the 90th day, significant decreases (P<0.001) were evidenced when dietary niacin contents exceeded 50 ppm, and the variations were all the more severe since dietary niacin contents were high (200-300 ppm): the highest value (1.14 g/l) was obtained in control group and the lowest value (0.78 g/l) in the group supplemented by 300 ppm niacin. Serum triglyceride concentrations (Table III) were significantly affected by niacin treatment at 30 and 90 days. At 30 days, significant decreases of serum triglyceride concentrations (P<0.001) were only evidenced in groups supplemented with the 2 highest doses of niacin (250 and 300 ppm), whereas at the 90th day, serum triglyceride concentrations were significantly reduced in all groups treated by dietary niacin except for the group received the lowest content of niacin (i.e. 50 ppm). Moreover, the decreases of serum triglyceride concentrations were more intense in groups received high dietary niacin contents (200-300 ppm). At 60 days, gradual, but not statistically significant decreases of this biochemical parameter were observed according to the niacin contents.

Results reported in Table IV show the effects of niacin treatment on egg characteristics. Before niacin supplementation (pre-experimental period), we have checked that egg production was quite similar among the different groups. High niacin supplementation (200 and 250 ppm) increased the egg production on 60-90 day period (83.94% and 85.31% respectively) when compared to the control (80%). During the other periods, niacin had no specific effect on egg production. Significant increases of egg specific gravity (P<0.05) were observed at the 90th day of experiment. But, this effect was not correlated with dietary niacin doses. No effect of vitamin supplementation on egg weight and damaged egg ration was recorded.

Niacin treatment had significantly affected food intake on the 30-60 day period (P<0.05, Table IV). The highest values were obtained from 200 and 250 ppm niacin supplemented groups (106.86 ± 1.69 and 106.88 ± 1.58 g/hen/day respectively vs. 101.79 ± 0.83 g/hen/day for control group: P<0.05). The feed conversion ratio (Table IV) was also higher in layer hens treated by high doses of dietary niacin (above 200 ppm) than in the other groups during the same period (2.05 ± 0.03 kg food / kg egg in the group treated by 200 ppm niacin vs. 1.90 ± 0.03 kg food / kg egg in the control group, P<0.05). During the other periods, niacin addition into diets had no effect either on food intake nor food efficiency. At the end of experiment (0-90 day period), no difference in body weight was seen between the different groups (Table IV). Besides, niacin supplementation in diets (50 to 300 ppm) did not modify the hen layer mortality.

Table III : Egg yolk weight, egg yolk cholesterol and serum biochemical parameters at different experimental periods (30-60 and 90 days) according to the dietary niacin contents (ppm). Results are expressed as mean ± SEM.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Groups</th>
<th>30 ppm</th>
<th>50 ppm</th>
<th>100 ppm</th>
<th>150 ppm</th>
<th>200 ppm</th>
<th>250 ppm</th>
<th>300 ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egg yolk weight, g</td>
<td>Control</td>
<td>15.83 ± 0.16</td>
<td>15.84 ± 0.20</td>
<td>15.80 ± 0.26</td>
<td>15.75 ± 0.28</td>
<td>15.65 ± 0.32</td>
<td>15.26 ± 0.32</td>
<td></td>
</tr>
<tr>
<td>Serum cholesterol concentrations, mg/dl</td>
<td>Control</td>
<td>1.32 ± 0.11</td>
<td>1.33 ± 0.12</td>
<td>1.08 ± 0.11</td>
<td>1.09 ± 0.11</td>
<td>1.13 ± 0.06</td>
<td>1.05 ± 0.06</td>
<td>1.00 ± 0.06</td>
</tr>
<tr>
<td>Serum triglyceride concentrations, mg/dl</td>
<td>Control</td>
<td>1.83 ± 0.17</td>
<td>1.87 ± 0.12</td>
<td>1.64 ± 0.12</td>
<td>1.64 ± 0.12</td>
<td>1.67 ± 0.12</td>
<td>1.60 ± 0.12</td>
<td>1.22 ± 0.08</td>
</tr>
<tr>
<td>Feed conversion ratio</td>
<td>Control</td>
<td>1.76 ± 0.02</td>
<td>1.80 ± 0.02</td>
<td>1.52 ± 0.04</td>
<td>1.47 ± 0.05</td>
<td>1.40 ± 0.05</td>
<td>1.33 ± 0.05</td>
<td>1.26 ± 0.07</td>
</tr>
</tbody>
</table>

Means within a column with no common superscript differ (P<0.001), according to Duncan's multiple range test.

Values represent the mean ± SEM of 7 groups of 35 eggs from layers hens per treatment.

Values represent the mean ± SEM of 7 groups of 49 layers hens per treatment.
In our study, we have shown that niacin supplementation in diets has significantly decreased serum cholesterol and triglyceride concentrations and egg yolk concentration without harming egg qualities (no reduction of egg production and of egg weight and no increase of damaged egg ratio). Moreover, niacin treatment has improved egg specific gravity independently of the dietary vitamin content, and even an increase of egg production was noticed during the third period of experiment (60-90 days) with the higher doses of niacin (> 200 ppm). On the other hand, diets enriched by niacin have not induced any deleterious effect on zootechnical performances of layer hens, although slight and transient increases of food intake and feed conversion ratio were observed with the higher doses (>200 ppm) during the second period of experiment (30-60 days). Previous reports have generally failed to show improvement of egg weight [16, 17] or of egg production [13, 16, 26] in response to niacin supplementation. However, LEESON et al. [17], reported an increase of egg production in birds received 66 and 132 ppm niacin in comparison to birds supplemented with

| Table IV : Egg characteristics and performances of layer hens during experimental periods according to dietary niacin contents (ppm). Results are expressed as mean ± SEM. |

**Discussion**

In our study, we have shown that niacin supplementation in diets has significantly decreased serum cholesterol and triglyceride concentrations and egg yolk concentration without harming egg qualities (no reduction of egg production and of egg weight and no increase of damaged egg ratio). Moreover, niacin treatment has improved egg specific gravity independently of the dietary vitamin content, and even an increase of egg production was noticed during the third period of experiment (60-90 days) with the higher doses of niacin (> 200 ppm). On the other hand, diets enriched by niacin have not induced any deleterious effect on zootechnical performances of layer hens, although slight and transient increases of food intake and feed conversion ratio were observed with the higher doses (>200 ppm) during the second period of experiment (30-60 days). Previous reports have generally failed to show improvement of egg weight [16, 17] or of egg production [13, 16, 26] in response to niacin supplementation. However, LEESON et al. [17] reported an increase of egg production in birds received 66 and 132 ppm niacin in comparison to birds supplemented with
only 22 ppm. This study also demonstrated a positive effect of niacin on egg quality: 20 week-old birds treated by 44 or 132 ppm niacin have laid eggs, that presented a superior shell quality in comparison to control birds (no supplemented niacin). TRIEBEL [31] also reported that a dietary niacin supplementation (25 to 75 ppm) has induced enhancement of egg production and of egg weight in layer hens. These beneficial actions of niacin on egg characteristics were not correlated with increases of food intake in layer hens [16, 17, 38]. In the same way, VOGT et al., [33] did not find any effect of nicotinamide supplementation (>27 ppm) on growth or food efficiency of broilers. In an other study conducted on one day old ducklings, a dietary niacin supply (30 to 120 ppm) during 10 weeks did not significantly modify either the zootechnical performances (body weight gain or food intake) nor cholesterolemia [8]. By contrast, body weight and food efficiency increased in turkey poults fed with niacin (100 ppm) enriched diets [19], OH et al., [25] have also found that food consumption enhanced on one week old white Leghorn chicks and consequently induced a significant weight gain when birds supplemented by low doses of niacin (15 ppm) whereas high dietary niacin (60 ppm) would depress food intake. So, these authors concluded that the niacin dose of 30 ppm would be indicated for optimal growth in broilers [25]. Moreover, a 2% increase of food conversion ratio and a 1% increase of body weight were evidenced in broilers supplemented by niacin (30 ppm) during 7 weeks and high doses (180 ppm) were able to improve the growth gain and the food efficiency by a factor of 4% [27].

Decreases of cholesterol concentrations in egg yolk were obtained precociously from the first period (1-30 days) whatever the dietary niacin doses and were dose dependent. The effects have persisted until the last period of experiment when niacin doses were above 50 ppm. Our results are in agreement with previous data of LEIBETSEDER [18] who has also reported such effects of niacin supplementation on egg yolk cholesterol concentrations. However, in study of LEESON et al., [17] no effect of niacin supplementation with very high dosages (>1022 ppm) on egg yolk cholesterol concentration was found. Although reduction of egg yolk cholesterol content seems to be beneficial for human health, it is well known that a normal egg consumption does not overload cholesterolemia of healthy human because a dietary cholesterol supply induces a decrease of endogenous biosynthesis and an increase of cholesterol excretion after hepatic conversion into biliary acids [27]. Nevertheless, as most of the cholesterol deposited in egg yolk is essential for embryonic development [22], it would be necessary to keep sufficient cholesterol content in egg.

Although the observed variations in serum cholesterol concentrations during the second period (30-60 days) were not statistically significant, this biochemical parameter also tended to decrease in hen groups fed with niacin enriched diets. On the 90th day, cholesterolemia was markedly and significantly diminished in layer hens supplemented by niacin (>100 ppm). In human medicine, niacin therapy is used for reducing cholesterolemia. In this way, ALDERMAN et al., [1] and NARASINGA et al., [23] showed that dietary supplementation with high doses of niacin (up to 2-3 g / day) was effective for reducing cholesterolemia and for improving the ratio of cholesterol to high density lipoproteins (HDL). WITZUM [38] also demonstrated that cholesterolemia was reduced by 25 to 30% in humans treated with high niacin contents.

Serum triglyceride concentrations were precociously reduced (on the 30th day) with high niacin contents (>250 ppm) and like cholesterolemia, marked and significant decreases were noticed on the 90th day of experiment in all niacin supplemented groups except for the 50 ppm dose. But LEIBETSEDER [18] did not succeed in reducing serum triglyceride concentrations of 23 week-old layer hens treated by high niacin doses (500 ppm) during 15 weeks.

Cholesterol metabolism in the laying hen has been under investigation for over three decades. Cholesterol intake from a conventional laying diet is minimal, and endogenous synthesis in hen is absolutely required for providing organism with cholesterol needed for egg, or used as structural component of cell membranes and as precursor to sex and adrenal hormones, vitamin D and the bile acids. The liver and the ovary are the primary sites of cholesterol biosynthesis in the laying bird [35, 36]. However, the liver is the major source of most lipids found in egg yolk [29, 36]. Although most of the cholesterol found in the yolk is synthesized by liver, transported into blood by lipoproteins and deposited in developing follicles, the plasma cholesterol concentration is not closely associated with the concentration of yolk cholesterol [29, 34, 35]. The synthesis of cholesterol is a highly dynamic process subject to many controlling factors. The early steps in the formation of cholesterol from acetyl-CoA are common with other metabolic pathways (e.g., synthesis of ketone bodies and fatty acids). The prime locus of metabolic control of cholesterol synthesis is the formation of mevalonic acid catalysed by the 3-hydroxy-3-methylglutaryl coenzyme A reductase (HMG-CoA reductase). Several variables, including nutritional factors, levels of dietary fat and hormonal factors, have been shown to control efficiently this enzyme. Cholesterol itself acts as a very effective negative feed back inhibitor of synthesis by decreasing HMG-CoA reductase activity [4, 35]. VARGAS et al., [32] concluded that under normal dietary conditions, the laying hen is capable to synthesise cholesterol in excess of needs for yolk deposition and that an inhibition of HMG-CoA reductase activity greater than 43% would be required to alter egg cholesterol deposition. It would be of interest to examine the effects of dietary factors on HMG-CoA reductase activity. Perhaps, niacin would participate to efficiently reduce liver HMG-CoA reductase activity through its oxidative form (NAD(P)⁺) and consequently would decrease the cholesterol deposition in the egg yolk.

As a dietary factor, niacin occurs in the metabolism through the formation of oxidoreduction coenzymes (NAD and NADP). It is well known that catalytic activity of several enzymes implicated in lipid metabolism are strongly regulated by short term mechanisms (allosteric effectors, phosphorylation sites) and by long term mechanisms (modu-
The results indicated that the dietary niacin supplementation with 50 to 300 ppm significantly decreased the egg yolk and serum cholesterol concentrations; the serum triglyceride concentrations of laying hens had also been affected. The niacin depressing effects on lipid metabolism in layer hens requires further investigations in order to well characterize these metabolic effect and to biochemical mechanisms of niacin action.

Acknowledgement

The authors wish to thank Dr. S. Dere for assistance with the statistics.

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