The effects of supplemental niacin in laying hen diet on performance and egg quality characteristics

T. GUNGOR, A.A. YIGIT and M. BASALAN

SUMMARY
This study was carried out to determine the effects of dietary niacin (0, 250, 500, 1000 and 1500 mg/kg ration) on layer performance. A total of 120 commercial hens (28 weeks of age) were divided in five groups, each containing 24 hens. Feeding period lasted 13 weeks. Hens were fed in groups, with adlibitum access to feed and water. Egg production, feed conversion, egg breaking strength and shell thickness were significantly (P < 0.05) increased, by the treatments. In addition some interior egg quality parameters were affected positively with increased niacin level in the diet (P < 0.05).

It was concluded that niacin in the diet may have a positive role in layer performance.

KEY-WORDS : Niacin - hen - egg production - egg quality.

RÉSUMÉ
Les effets de la supplémentation en niacine de la ration des poules pondeuses sur la qualité des œufs et les performances de ponte. Par T. GUNGOR, A.A. YIGIT et M. BASALAN.

Cette étude a été effectuée pour déterminer les effets de la niacine (0, 250, 500, 1000 et 1500 mg/kg) sur les performances de poules pondeuses. Pendant l’étude, on a employé 120 poules de 30 semaines. On a formé 5 groupes dont chacun contenant 24 poules. L’étude a duré 13 semaines. Elles ont été alimentées en groupes. L’eau et l’aliment ont été donnés ad libitum.

La production d’œuf, l’efficacité alimentaire, le poids vif, la résistance des œufs à la casse ont augmenté significativement (p < 0.05). En plus, certains paramètres de qualité intérieure des œufs ont été améliorés effectués avec le niveau d’ajout de niacine (p < 0.05).

En conclusion, la niacine dans la ration peut avoir un effet positif sur la performance des poules pondeuses.


Introduction
Niacin (Vitamin B3) is a water-soluble vitamin required by all living cells. It functions in the release of energy from carbohydrates, fats and proteins. Niacin is a major constituent of the coenzyme NAD (nicotinamid adenine dinucleotide) and NADP (nicotinamid adenine dinucleotide phosphate). Niacin can be synthesized in the body from tryptophan if it exceeds requirements [11]. On average it takes 50 to 60 mg of tryptophan to produce 1 mg of niacin [7].

Niacin is widely distributed in foods from both plant and animal origin. Although cereal grains and their by-products contain niacin, much of the ingested niacin is in a form unavailable to the animal, being bound in a polysaccharide complex, nyacitin. There are also differences in the utilisation of naturally occurring niacin between individual animal species and various age groups [11].

There has not been many recent research in response to high level of dietary niacin. Due to niacin antagonists in diet and bound structure in grains and other feedstuffs, higher doses of supplemental niacin may be needed for optimal production [11]. Studies in primates showed that pharmacological doses of niacin to treat central nervous system defects and hypercholesterolemia did not show any clinical symptom [3]. Niacin deficiency results in poor utilisation of calcium and phosphorus, which are required for normal bone formation and egg production. Niacin deficiency studies with laying hens indicate that inadequate supplementation reduces feed intake, egg production and egg hatchability [9].
NRC [12] set the niacin requirement of laying hens as 10.0 mg/kg. since the niacin absorption and utilization are affected by many factors including complexation of niacin with macromolecules in cereals, tryptophan and vitamin B6 levels in diet, higher supplementation levels than requirement may be needed for laying hens. Niacin requirement of livestock and RDA for humans were based on previous research and niacin equivalent depends on protein content of the diet. Previous research indicated that supplemental niacin with the levels of 22, 44, 66 and 132 mg/kg in layers diet increased egg production, decreased eggshell deformation significantly, tended to decrease egg cholesterol content but did not improve other egg quality characteristics [10]. However, other recent findings were controversial. HARMS and BOOTWALLA postulated that lower doses of supplemental niacin (36 mg/kg) prior to laying period did not improve pullet performance [4].

Therefore the aim of this study was to determine the effect of various levels of niacin in layers diet on external and internal quality parameters of eggs.

**Materials and methods**

One hundred and twenty, 30-wk-old commercial laying hens were randomly selected. Birds were placed in individual wire cages and reared under controlled environmental conditions (17 h light per day). The experimental period lasted 13 weeks. The hens were divided into five groups each containing 24 hens. The pullets were assigned five dietary treatments that consisted of 0, 250, 500, 1000 and 1500 mg/kg supplemental niacin in a corn, barley and soybean meal basal diet (Table I). ME value of the diet was calculated and CP, Ca and P contents were determined with methods described by AOAC [1]. Starting from 2 weeks prior to 13-week experimental period, feed and water were available for ad libitum consumption throughout the study.

Egg production was recorded on a daily basis and feed consumption was calculated on a weekly basis throughout the experiment. Eggs produced for the last day of each biweekly period were saved for determination of egg weights. Individual body weights of birds were determined at the beginning and at the termination of the experiment. All eggs collected were weighted at the end of each 14-day period. Egg shell quality measurements were done at 6-week intervals, between 30 and 42 weeks of age. Eggs collected were identified by groups and were used for exterior and interior egg quality determinations. Before any egg quality measurements were taken in the laboratory, the eggs were stored overnight at room temperature. Egg weight in grams, Haugh unit score, yolk color score [15] and shell thickness [13] in millimetres were measured using a balance, a Mitutoya micrometer (Mitutoya Inc., Japan), a Roche yolk color fan and a micrometer, respectively.

![Table I. — Percentage composition of basal diet.](image)
The experiment was treated as Completely Randomised Blocks and Analysis of Variance was applied on the design in SPSS [14]. Significant means (p < 0.05) of measured parameters were regressed against the niacin supplementation levels and correlation coefficients were presented in the tables. The significance of differences between treatment means was tested by using DUNCAN’s multiple range test [2] and P < 0.05 was accepted as significant.

Results and discussion

Results in Table II show niacin treatment had no significant effect on feed intake and body weight at 30 wk of age. However, egg production increased in response to added niacin, being significant (P < 0.05) for birds fed ≥ 500 mg/kg supplemental niacin, relative to control birds. Maximum egg production was obtained by the addition of 1500 mg/kg niacin (correlation coefficient 0.65). This finding agrees with results of KUCUKERSAN [8] and LEESON et al [10]. Although KUCUKERSAN found that egg production increased linearly with 50 and 100 ppm supplemented niacin and reached 87.65 % rate with 100 ppm, egg production data of present study was paralleled with supplemental niacin and reached the 87.43 % with 1500 ppm supplemental niacin. Similarly, LEESON and his co-workers [10] indicated that moderate niacin supplementation of layer diet improved egg production significantly, however the authors did not analyse the production parameters except egg weight and cholesterol level in eggs laid by hens supplemented with 500 and 1000 ppm niacin which is closer to the therapeutic doses in humans. JENSEN and his colleagues [6] in earlier work could not show any improvement on egg production of cage layer hens supplemented with 44 mg/kg niacin, although 44 mg/kg niacin combined with 110 mg/kg biotin tended to increase egg production. The results indicated that egg production was improved by adding niacin for laying hens.

Body weight of the layers in control groups at 42 wk of age was significantly higher than treatment groups. Our findings contradict with the previous study, done by LEESON et al, however the initial body weight was not reported in that study. [10]. Discrepancy between results might be attributed to the different breeds and nutrient densities and the difference in the lengths of the experiments. Pharmacological doses of niacin in humans significantly lowered blood cholesterol and low density lipoproteins, but its effect on adipocytes were not hypothesized. Our findings still debates the possible cause of weight loss.

Feed conversion (kilograms of feed per dozen eggs) was significantly higher for hens fed ≥ 500 mg/kg supplemental niacin, due to increased egg production although feed intake was similar in all groups, supporting all previous works [5, 6, 10].

Using up to 1500 mg/kg supplemental niacin had no effect on egg weight and egg shape index (Table III). However, a significant increase (P < 0.05) in egg-breaking strength and shell thickness were obtained by the addition of 250 and 500 mg/kg niacin, respectively. LEESON and his group [10] indicated the eggshell deformation decreased significantly (P < 0.01) when layer diet was supplemented with 44 and 132 ppm niacin which was in agreement with our result.

Data on effects of niacin on interior egg quality are presented in Table IV. Albumen index, Haugh unit and yolk colour were significantly (P < 0.05) affected during the experiment, by the addition of niacin. Otherwise, dietary niacin did not have a significant (P > 0.05) effect on yolk index. Maximum albumen index and haugh unit values obtained by the addition of 1500 mg/kg niacin. Some of the parameters studied in present experiment were not investigated in previous works. Only KUCUKERSAN [8] indicated that there were no response on albumen index and Haugh unit may be due to low levels of niacin supplementation in her study. Improvements on yolk colour might affect Turkish customer habits which tends to prefer high yolk colour.

In conclusion, laying hens supplemented with high level of niacin have improved egg production, feed conversion and egg quality. However further research is needed to investi-

### Table II. — Performance of laying hen diets different levels of supplemental niacin.

<table>
<thead>
<tr>
<th>Supplemental niacin (mg/kg)</th>
<th>Egg production</th>
<th>Feed intake</th>
<th>Feed conversion</th>
<th>Body weight at age</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(% hen-day)</td>
<td>(g/hen/day)</td>
<td>(kg/doz)</td>
<td>(g)</td>
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<tr>
<td>0</td>
<td>79.76d</td>
<td>121.32</td>
<td>1.83a</td>
<td>1893.58</td>
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<td>1.80a</td>
<td>1892.83</td>
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<td>500</td>
<td>82.28bc</td>
<td>120.52</td>
<td>1.76ab</td>
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<tr>
<td>1000</td>
<td>84.47b</td>
<td>121.30</td>
<td>1.73ab</td>
<td>1846.42</td>
</tr>
<tr>
<td>1500</td>
<td>87.43a</td>
<td>121.07</td>
<td>1.66b</td>
<td>1823.83</td>
</tr>
</tbody>
</table>

Correlation Coefficients: 0.65 -0.44 -0.37

a-d. Means with different superscripts differ significantly (P < 0.05)

1 Means from 13-wk period
gate interior egg quality characteristics deeply and subclinical pathological symptoms with high level of niacin supplementation. In addition, economics of adding large amount of niacin to the ration needs further evaluation.

References


<table>
<thead>
<tr>
<th>Suplemental niacin (mg/kg)</th>
<th>Egg Weight1</th>
<th>Egg shape index2</th>
<th>Egg-breaking strength3</th>
<th>Shell thickness2</th>
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<tr>
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<td>61.95</td>
<td>76.24</td>
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<td>37.54b</td>
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<td>61.43</td>
<td>76.37</td>
<td>3.19ab</td>
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<td>61.56</td>
<td>76.29</td>
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<tr>
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<td>77.42</td>
<td>3.24a</td>
<td>38.78a</td>
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</table>

Correlation Coefficients

- - 0.15 0.21

TABLE III. — Effects of niacin on egg and shell quality.

<table>
<thead>
<tr>
<th>Suplemental niacin (mg/kg)</th>
<th>Yolk index</th>
<th>Albumen index</th>
<th>Haugh unit</th>
<th>Yolk colour</th>
</tr>
</thead>
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<tr>
<td>0</td>
<td>43.29</td>
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<td>79.57b</td>
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<tr>
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<td>81.88b</td>
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</tr>
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</table>

Correlation Coefficients

- - 0.20 0.27 0.08

TABLE IV. — Effects of niacin on interior egg quality1.

a-c Means with different superscripts differ significantly (P < 0.05)
1 Means from three 6-wk period