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CHANGES IN THE CONTENT OF MINERAL COMPONENTS IN TISSUES OF TURKEYS RECEIVING A SUPPLEMENT OF Cu CHELATE WITH LYSINE

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INTRODUCTION

Copper is an element that in animal organisms occurs in very small quantities (1.5–2.5 mg·kg⁻¹ body mass in mammals, 1.2–1.5 mg·kg⁻¹ body mass in poultry). It is a component of all animal tissues, but some of them have a special tendency to accumulate this element. The highest copper concentration was found in liver, brain and kidneys (Labbier, Leclercq 1995).

Despite the fact that demand for copper in turkeys is not high, and according to NRC (1984) it equals 6-8 ppm, its limited absorption from natural feeds (about 20% according to the Norms of Poultry Feeding, 1996) caused by antagonistic action of other components may cause secondary deficit of this element in the organism. Among the factors limiting absorption and use of copper the following ones are mentioned: reducing factors (ascorbic acid, cistene, reduced glutation), soluble fractions of non-starch polysaccharides (Bedford et al.1991), presence of chelating compounds, and antagonistic action of other mineral components (Koreleski 1997, Brzozowska 1998).
Copper absorption is also in a significant way dependent on its chemical form. Copper in the form of inorganic compounds (CuO, CuCl₂ and CuSO₄), as a growth stimulator with a strong anti-microbiological activity has been used for a long time in turkey rearing.

However, now it is thought that mineral-organic structures, that is chelates, are the best source of mineral elements in animal nutrition (Koreleski 1997, Pres 1997). Complexes of elements with amino acids or proteins may be absorbed in an unchanged form by the mucous membrane of the intestines with the use of the amino acids transport system, owing to which they are better absorbed by the organism (Ashmead 1993, Koreleski, 1997). Moreover, it is an advantage of chelate compounds that they do not introduce accompanying elements and contamination that can accumulate in the organism.

Cuítan and Gilíen (1993), comparing the effects of using mineral supplements in different chemical forms, showed that the use of bioplexes instead of inorganic forms contributed to improving the production results, that is better gains in body weight and superior use of feed by broiler chickens. In numerous studies it was also found that mineral-organic complexes cause an increase in dressing percentage and improve quality of the carcasses (Bonomi et al. 1993, Matyka, Korol 1997). On the other hand, Ferrari and Cagliero (1993) noted a favorable effect of amino acid chelates on the functions of the immune system, improvement of the health condition and vitality of the chickens. In our own studies (Makarski et al. 2002) a favorable effect of chelate compounds was found on formation of biochemical and hematological indices in turkey blood.

The aim of the present study was to define the effect of copper in the form of chelate with lysine as a supplement added to drinking water on body weight and accumulation of mineral components in selected turkey tissues.

MATERIAL AND METHODS

The study was conducted on 200 turkeys of the heavy type Big-6 during 16-week rearing. The birds were kept in the same zoo-hygienic conditions, optimal for fattening of slaughter turkeys. During the whole study the turkeys received ad libitum typical feed mixtures available on the Polish market, they had free access to water and remained under constant care of a veterinary doctor.

In the third week of rearing the birds were divided into two equal groups and the differentiating factor between the groups was copper supplementation. Group I was the control, whereas the experimental Group II received a supplement of chelate Cu with lysine in the amount of 10
mg Cu·dm⁻³H₂O. Because of possible antagonistic influence of various components of feed mixtures on Cu absorption, the experimental preparation was added to drinking water (SZKULELSKI 1995, BRZOSOWSKA 1998). The bioplex used in the experiment was a complex combination of the amino acid and Cu in the ratio 2:1, and it was prepared in the laboratory of the Biochemistry and Toxicology Department AU in Lublin.

After the rearing was finished, 10 turkeys were selected at random from each group, weighed and slaughtered. During the dissection (HÄHN, SPINDER 2002) the mass of breast and thigh muscles, livers and kidneys was determined. In the samples of tissues and in all the mixtures used during the experiment, after wet mineralization in HClO₄ and HNO₃ (in the ratio 5:1) the basic mineral elements content was determined. This was done by way of atomic absorption spectrophotometry (AAS) on the UNICAM 939 apparatus.

The data were subjected to statistical analysis using the Statistica 5.0 PL 97 programme with the ANOVA one way factor analysis, accepting the significance levels of 0.05 and 0.01.

RESULTS AND DISCUSSION

Table 1 presents concentrations of selected mineral elements in the feeds used in turkey nutrition. Analysis of the results showed that Cu, Zn and Fe content was higher than the level recommended by the Polish norms (Norms for Poultry Feeding 1996) and NCR (1984). The Cu level in the mixtures was considerably higher than the turkey requirement, although it did not pose a threat to the health of turkeys since, as the Norms for Poultry Feeding (1996) state, those birds are highly tolerant to the excess of this element and it is only the Cu concentration 25-fold higher than the organism’s requirement that may prove toxic.

Zinc requirement in turkeys (depending on the stage of rearing) is 70-90 mg in 1 kg feed. The results presented in the table show that only mixtures used between 5th and 12th week of the turkeys’ life contained slightly more zinc than required by turkeys.

The iron level in turkey feeds recommended by NRC (1984) is 50-80 mg·kg⁻¹, whereas in the analyzed mixtures the content of this microelement was between 136 and 178 mg·kg⁻¹. Negative results of an increased concentration of Fe in feeds are rarely observed in practice, nevertheless increasing the recommended dose, which meets the requirement, by 15- to 20-fold may result in toxic effects. NOY et al. (1994) point that with the requirement equals 60 mg·kg⁻¹ and the minimum toxic dose of Fe is as much as 2000 mg·kg⁻¹.
All the mixtures used in the experiment contained the optimum level of Mg, but the Ca concentration was lower than the determined requirement (Norms of Poultry Feeding 1996). According to Larrier and Leclercq (1995), a moderate deficiency of this element clearly affects the growing process of very young turkeys, whereas at the later stage of their lives it does not have any bad influence on the birds’ organisms.

<table>
<thead>
<tr>
<th>Mieszanki Mixture</th>
<th>Ca (g·kg⁻¹)</th>
<th>Mg (g·kg⁻¹)</th>
<th>Cu (mg·kg⁻¹)</th>
<th>Zn (mg·kg⁻¹)</th>
<th>Fe (mg·kg⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I 1.-4. tydzień odczynu rearing week</td>
<td>5.7590</td>
<td>1.2680</td>
<td>48.480</td>
<td>87.000</td>
<td>136.00</td>
</tr>
<tr>
<td>II 5.-8. tydzień odczynu rearing week</td>
<td>4.8420</td>
<td>1.3490</td>
<td>39.324</td>
<td>100.00</td>
<td>157.00</td>
</tr>
<tr>
<td>II 9.-12. tydzień odczynu rearing week</td>
<td>5.5430</td>
<td>1.5140</td>
<td>53.234</td>
<td>106.00</td>
<td>170.00</td>
</tr>
<tr>
<td>IV 13.-16. tydzień odczynu rearing week</td>
<td>4.9580</td>
<td>1.1020</td>
<td>25.646</td>
<td>81.000</td>
<td>178.00</td>
</tr>
</tbody>
</table>

All the mixtures used in the experiment contained the optimum level of Mg, but the Ca concentration was lower than the determined requirement (Norms of Poultry Feeding 1996). According to Larrier and Leclercq (1995), a moderate deficiency of this element clearly affects the growing process of very young turkeys, whereas at the later stage of their lives it does not have any bad influence on the birds’ organisms.
A supplement of Cu chelate with lysine in the amount of 10 mg Cu·dm\(^{-3}\) H\(_2\)O used in group II increased the final body mass of the birds as compared with the control group (Table 2), and the differences were confirmed statistically (\(p=0.05\)). Efficiency of using increased doses of copper (from 125 to 250 mg·kg\(^{-1}\) feed in the form of CuSO\(_4\)) as growth stimulators in chickens was experimentally proven by other authors (PESTI, BAKALI 1996). On the other hand, studies on turkeys by POLONIS et al. (1999) and on chickens by POTT et al. (1994) did not confirm significant usefulness of Cu for stimulating birds’ growth.

The mass of turkey tissues did not show greater differences between the groups, although it is worth mentioning that in birds whose diet was enriched with a supplement of copper, a slight increase of the mass of thigh muscles and kidneys was noticed.

Table 3 presents determination of the mineral components in turkeys tissues. In breast muscles of the birds receiving a supplement of copper a statistically significant decrease in Ca level was noted, whereas the content of Mg, Cu, Zn and Fe was not considerably different in between the groups. In thigh muscles of the turkeys of the group supplemented with chelate an increase in the content of all the analyzed mineral components was observed, but statistically significant differences were found only in the Ca level.
A similar tendency was noticed in livers. The level of all determined mineral elements in the experimental group was higher than the results found in the control group, whereas in the kidneys of birds whose diet was enriched by a supplement of Cu a decrease was found in Mg content and a slight increase in accumulation of other mineral elements.

Because of the Cu supplement used in the experiment, retention of this component in the tissues as especially carefully studied. The highest Cu concentration was determined in livers, and the lowest level of the element was found in breast muscles. Similar results were obtained in our earlier studies (MAKARSKI et al. 2004), and those reported by in other authors (POLONIS et al. 1999) dealing with absorption of copper from different chemical compounds.

CONCLUSION

1. The feed mixtures used in turkey nutrition contained a lowered, as compared to the requirements, level of Ca and an increased Cu, Zn and Fe concentration, which, however, did not influence the birds’ health.

2. A supplement of Cu chelate with lysine in the amount of 10 mg Cu·dm⁻³H₂O caused an increase in the final body mass of the turkeys, but it did not considerably influence the mass of the analyzed tissues.

3. Supplementing with a bioplex affected statistically significantly the Ca content, which fell in breast muscles and rose in thigh muscles of the turkeys.

4. Livers were characterized by the highest retention of Cu, whereas the least amounts of this element were accumulated in breast muscles of the birds.

5. A long-term application of copper did not result in excessive accumulation of this element in kidneys and muscles of turkeys and did not pose a threat to consumers’ health, as the copper content in these tissues did not exceed the permissible norms (5 mg·kg⁻¹; according to PN-A-86524:1994).

REFERENCES


ZMIAŃY ZAWARTOŚCI SKŁADNIKÓW MINERALNYCH W TKANKACH INDYKÓW OTRZYMUJĄCYCH DODATEK CHELATU Cu Z LIZYNĄ

Słowa kluczowe: miedź, indyki, składniki mineralne, tkanki.

Abstrakt

Badania przeprowadzono na 2 grupach indorów typu Big-6 podczas 16-tygodniowego odcho-wu. Czynnikiem doświadczalnym był dodatek miedzi w formie chelatu z lizyną w ilości 10 mg Cu·dm⁻³H₂O.

Celem badań było określenie wpływu miedzi jako dodatku do wody pitnej na masę ciała oraz kumulację składników mineralnych w wybranych tkankach indyków.

Wykazano, że dodatek chelatu spowodował zwiększenie końcowej masy ciała indorów, natomiast nie wpłynął w znaczący sposób na masę analizowanych tkanek. Stwierdzono, że zastosowanie Cu wpłynęło na wzrost zawartości Cu, Zn i Fe we wszystkich badanych tkankach. Największą retencję Cu wykazano w przypadku wątroby, natomiast najmniejsze ilości tego pierwiastka kumulowały się w mięśniach piersiowych ptaków. Długotrwała aplikacja miedzi nie spowodowała nadmiernej kumulacji tego składnika w nerkach i mięśniach indyków, co nie stanowiło zagrożenia dla zdrowia konsumentów, gdyż jej zawartość nie przekraczała dopuszczalnych norm (5 mg·kg⁻¹; wg PN-A-86524:1994).

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Key words: copper, turkeys, mineral components, tissues.

Abstract

Investigations were performed using 2 groups of turkeys Big-6 type turkeys during 16 - week rearing. Addition of copper in the form of chelate with lysine in the amount of 10 mg Cu·dm⁻³H₂O was an experimental factor.

The aim of the present study was to define the effect of copper, as a supplement to drinking water on body mass and on accumulation of mineral components in selected turkey tissues.

Analysis of the obtained results has shown that a supplement of chelate caused an increase of the final body mass of the turkeys, but it did not considerably influence the mass of the analyzed tissues. It was found that the copper affected the increase of Cu, Zn and Fe contents, in all tissues studied. Livers were characterized by the highest Cu retention, whereas the least amounts of this element were accumulated in breast muscles of the birds.

A long application of copper did not effect an excessive accumulation of this mineral component in kidneys and muscles of turkeys and did not pose a threat for the consumers' health, as the copper content in these tissues did not exceed the permissible norms (5 mg·kg⁻¹; according to PN-A-86524:1994).