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Results of the study of $M^{I}_{2} \cdot M^{II} \cdot L_2 \cdot NH_2O$ type citrates

I. Beshkenadze*, M. Gogaladze, N. Klarjeishvili, O. Lomtadze, G. Chagelishvili, L. Gogua

Ivane Javakhishvili Tbilisi State University, Petre Melikishvili Institute of Physical and Organic Chemistry, #31, A. Politkovskaya Str., Tbilisi, 0186, Georgia

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ABSTRACT

Heteronuclear chelate citrates of the general formula $M^{I}_{2} \cdot M^{II} \cdot L_2 \cdot nH_2O$ (where M^{I} and M^{II} = Mn, Zn, Fe, Co,Cu) have been synthesized. Premixes prepared on their basis were tested in nutrition of layer and broiler poultry. On the basis of experimental data we calculated economic efficacy of egg-laying for layers within 60 days from starting intense egg-laying. Economic efficiency of poultry rearing, for broilers, was calculated from the 7th day after hatching till the 35th day. Computations for broilers were made per 1000 broiler, while for layers – per 20 hens. In both cases four groups were used: I – control, when feed was balanced with the premix used generally at the factory; II group, experimental – with the premix that contained minimal doze of chelate citrates; III group, experimental – with premixes containing normal doze of chelate citrates and the IV group, experimental – with premix containing maximal dose of chelate citrates.

On the basis of the experiment results we can conclude that in all (three) experimental groups where the premixes were balanced with the synthesized chelate citrates, the profit, compared to the control group, was higher, while the highest profit was obtained from the group which was given feed with the premix balanced with maximum dose of chelates.

We have carried out physical and chemical study of heteronuclear citrates. Solubility of these citrates was investigated in various solvents. It was determined that these citrates are characterized by poor solubility in all solvents, both at room temperature and when heating.

To determine the nature of citrate ion deprotonation and linking with metals in the $M^{I}_{2} \cdot M^{II} \cdot L_2 \cdot nH_2O$ type chelate compounds, we made and studied their IR absorption spectra, according to which, the synthesized compounds are the internal type chelate compounds and as it was expected, all three deprotonated carboxylic groups of citrate acid form both ionic and coordination bounds with metal atoms.

Introduction

One of the main causes determining low quantitative and qualitative indices of food products is deficiency of biometals in plant, soil, agricultural animals and poultry. Therefore, the decisive role in the resolution of this problem is attributed to the provision of live organisms with optimal quantity and ratio of microelements. Besides, since they fulfill their functions in live organisms in the form of chelate compounds, filling in the deficit in microorganisms contributes to the sharp increase of biological activity of animals and poultry. This can be explained by the fact that biometals, when they are in the chelate form, show low toxicity, high assimilation ability and therefore increased efficiency of small doses. Application of biometals of this form contributes also to ecological safety. Inorganic salts are characterized by high toxicity, low assimilation capacity and low efficiency, due to formation of the poorly soluble and hardly digestible compounds in gastro-intestinal tract of animals and poultry [1–6]. Thus, the importance of admixes containing these compounds was proved theoretically and practically in poultry and animal nutrition [7–13]. The role of organic compounds (vitamins, amino acids, organic acids) and chelates which contain microelements for the metabolic processes of poultry and animal organisms is well known. Nevertheless, determination of methods of synthesis of chelate compounds which will contain oxy-acids, in particular the citric acid and microelements (Zn,Co,-Fe,Mn,Cu), study of physical and chemical properties and determination of efficiency of application of the synthesized compounds for nutrition - is still urgent today. (see Fig. 1)

* Corresponding author.
E-mail address: iamzebeshkenadze@yahoo.com (I. Beshkenadze).
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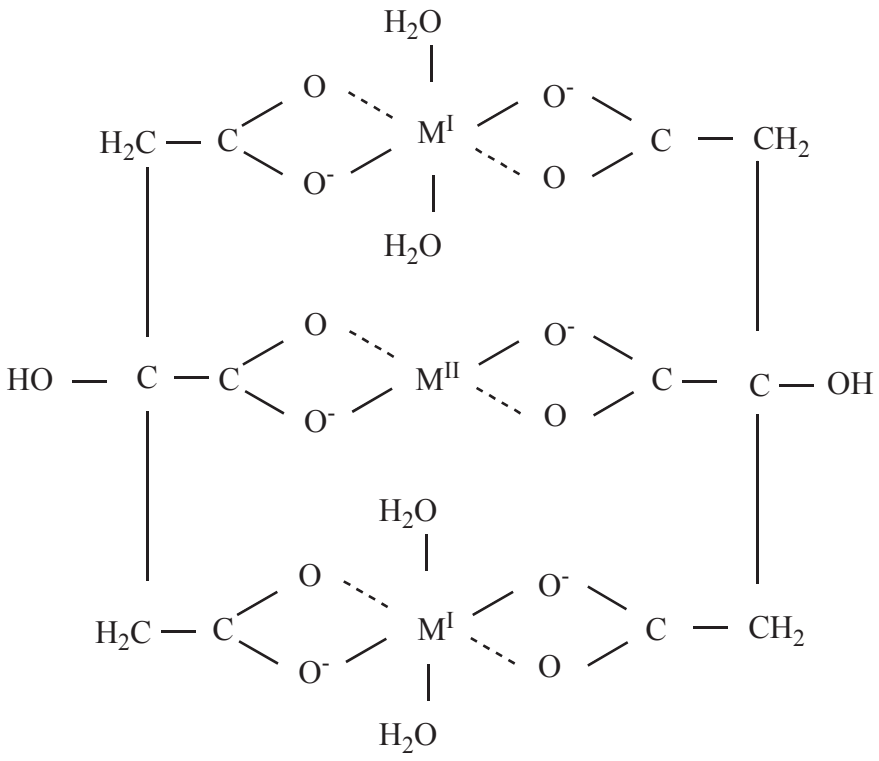

Fig. 1. Possible configuration of $M^{I}_{2} \cdot M^{II} \cdot L_2 \cdot nH_2O$ type compounds.

Computational method

Experiments aimed to study the following:

- Economic efficacy achieved through egg realization
- Profit gained through broiler realization
- Qualitative dissolubility of the synthesized compounds in various solvents
- Nature of citrate-ion, nature of its deprotonation and bonding with metals by the spectrophotometric method.

Results and analysis

Studies are continued at the Agrarian Chemistry Problem Laboratory for the creation of new generation premixes and for their testing in experiments [14–23]. With this in view, we have synthesized $M^{I}_{2} \cdot M^{II} \cdot L_2 \cdot nH_2O$ type chelate compounds (where M^{I} and M^{II} = Mn,Zn,Fe,Co,Cu); we determined their composition by the method of microelement analysis, determined their identity by their melting points and by X-Ray diffraction method; besides, their crystalline structure was determined and Roentgen-amorphous and iso-structural orders were revealed [24]. Premixes prepared on the basis of the synthesized chelate compounds were tested in the formula feed for broiler-chicks and layers. On the basis of the trial and main experiments we determined optimal composition and concentration of chelate form microelements in the premix [25,26].

We have computed economic efficiency of egg-laying according to the experiment results. Accounting period was started on the day of intense egg-laying and it lasted 60 days. Accounting period for economic activity of broiler rearing lasted from 7th day after hatching till the 35th day. In both cases experiments were carried out on one control and three experimental groups. For broilers the calculations were made per 1000 hen, while for layers – per 20 hen. Results are given in Table 1.

Qualitative solubility of the synthesized compounds in various solvents (water, alcohol, acetone, dimethyl form amide) has also been studied (Table 3).

IR adsorption spectra (400-4000 cm^{-1}) were recorded in Vaseline oil by the spectrophotometer "VARIAN" CARRY 100 to study the nature of deprotonation of citrate ion of the $M^{I}_{2} \cdot M^{II} \cdot L_2 \cdot nH_2O$ type synthesized chelate compounds and its binding with metals.

The average selling price of industrial egg, considering egg categories, amounts to 0.22 lari (Table 1). In the control group, when the premix available at the factory was added to the feed, in all 1034 eggs were obtained and through its realization 227.48 lari will be received, that is, commodity egg of 11.37 lari was obtained per hen. From the second group, when the minimum dose of heteronuclear citrate synthesized by us was added to the premix given to hens, 1087 commodity egg was obtained in all and by its realization 239.14 lari will be received, that is, if we calculate the sum per hen, we'll get– 11.96 lari. In the third group, when the normal dose of the synthesized heteronuclear citrates was added to the premix, in the whole period of the experiment 1113 commodity egg was obtained in all and by its realization 244.86 lari will be received, that is, at its calculation per hen, it formed 12.24 lari. From the fourth group, when maximum dose of heteronuclear citrates was added to the premix, in all 1127 commodity egg was obtained, and by its realization the factory will receive 247.94 lari, that is, at the calculation with respect to a hen - it amounted to 12,4 lari.

Thus, in the period of the experiment under accounting, the highest income per hen gained as a result of realization of egg will be obtained from the fourth group (which was given maximum dose of chelates) - 12.40 lari, which will exceed by 1.03 lari the income gained from hens of the control group by 0.44 and will exceed by 0.16 lari that obtained from the second and third groups.

To determine efficiency of broiler rearing we have calculated