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Zinc quantitative estimation in tuberous roots of sweet potato following hydromineral and phitohormonal treatments applied for the purpose of modification of the metabolism of biocompound accumulation

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Abstract

The sweet potato is one of the world's most important food crops because of its high nutritive value due of the content in biocompounds such as beta–carotene, carbohydrates and proteins. [7] [8] The edible part is made up from a system of very well developed tuberous roots, with remarkable sizes and various shapes function to the sort. [4]

The application of phytohormonal and hydromineral treatment simultaneously in the nutrition of plants is an efficient modality to modify the metabolism of accumulation of biocompounds in plants. [10]

The aim of these researches was to determine the maxim amount of zinc allowed to be adding by the phytohormonal and hydromineral treatment, which improves the nutritive quality of the sweet potato roots, but which do not cause an excessive accumulation in the plant. [1]

The substances with regulating action on the growth of plants represent an efficient and sensitive instrument for the guiding and control of processes of growth and development. [6] The phytohormones influence the process of growth and morphogenesis, regulate the physiological processes in various tissues and organs of the plant. [2]

The results showed that the treatment consist in 40 mg/L zinc together with phytohormons is the most efficient for the achievement of the maxim quality of the sweet potato roots without producing damages on the human health. [3]

Zinc, entering into composition of carbohydrate has a role in the respiration processes. It activates the enolization that takes part to the metabolism of carbohydrates. It moderates the action of polypeptidase and activates dipeptidase. It enters various processes which take place at the formation of chlorophyll. Zinc has an essential role on stimulation of the activity of auxins. It activates the enzymatic systems, the biosynthesis of P vitamins, and the development of fruits and seeds. [9]

It is a well-known fact that the excess of zinc can have bad consequences on the animal and vegetal metabolism. Thus, there is a requirement for an analysis to indicate to what extent the zinc used in the nutritive solution with which sweet potato is treated during its development has accumulated in the plant over the normal existing limits. [13]

The excess of zinc has serious consequences on the condition of human health. [14] The high concentration of zinc inhibits iron absorption and transport. Iron, entering the composition of hemoglobin has a major importance in the metabolism of mammals. The daily need for the human adult is of 15 mg. [15]

Keywords: sweet potato roots, phytohormonal treatment, hydromineral treatment, zinc, biocompounds, nutritive quality.

Material and method

The analyses were carried out on tuberous roots of sweet potato submitted to treatment with active physiological substances and of the nutrition with zinc chloride. The analysis implied the mineralization of vegetal material by means of the Kjeldhal method and the spectrophotometric quantitative determination with a dithizon reactive. [5]

The principle of the Kjeldhal method is based on mineralization; it means transformation of organic substances into inorganic ones by keeping the sample for analysis at high temperature in presence of concentrated mineral acids and of catalysts.

Zinc forms with dithizon, in the interval of pH = 4 – 11, an internal complex salt, soluble in $CHCl_3$ and CCl_4. It forms solutions of a red-violet color with maximum of absorption at wave length of 535 – 538 nm.

The color intensity is proportional with zinc concentration according to Lambert-Beer law in the domain of concentration of 0.04 – 0.07 μg Zn/ml. [12]

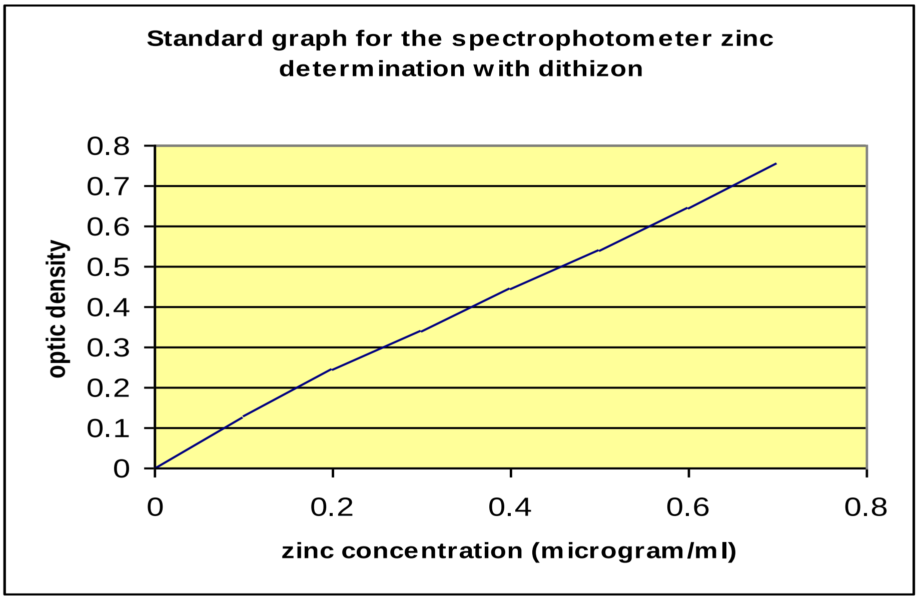
In the table 1 are show the standard concentration and optic density for our determination.

Table 1. Standard concentration of zinc and optic density

Standard	M	1	2	3	4	5	6	7
Zn^{2+} concentration (μg/ml)	0	0,10	0,20	0,30	0,40	0,50	0,60	0,70
Optic desity λ = 536nm	0	0,130	0,245	0,340	0,445	0,540	0,645	0,755

In graph 1 we show the Standard graph for spectrophotometric zinc determination with dithizon.

Graph 1



From previous determinations we have been ascertained that the value of 30mg/L for zinc chloride is optimum for the accumulation of bio-compounds in the tuberous roots of sweet potato. The vegetal material treated with the nutritive solution that contains phytohormones and zinc chloride of specified concentration will be submitted in the first phase to the analysis for the purpose of determination of zinc in roots.

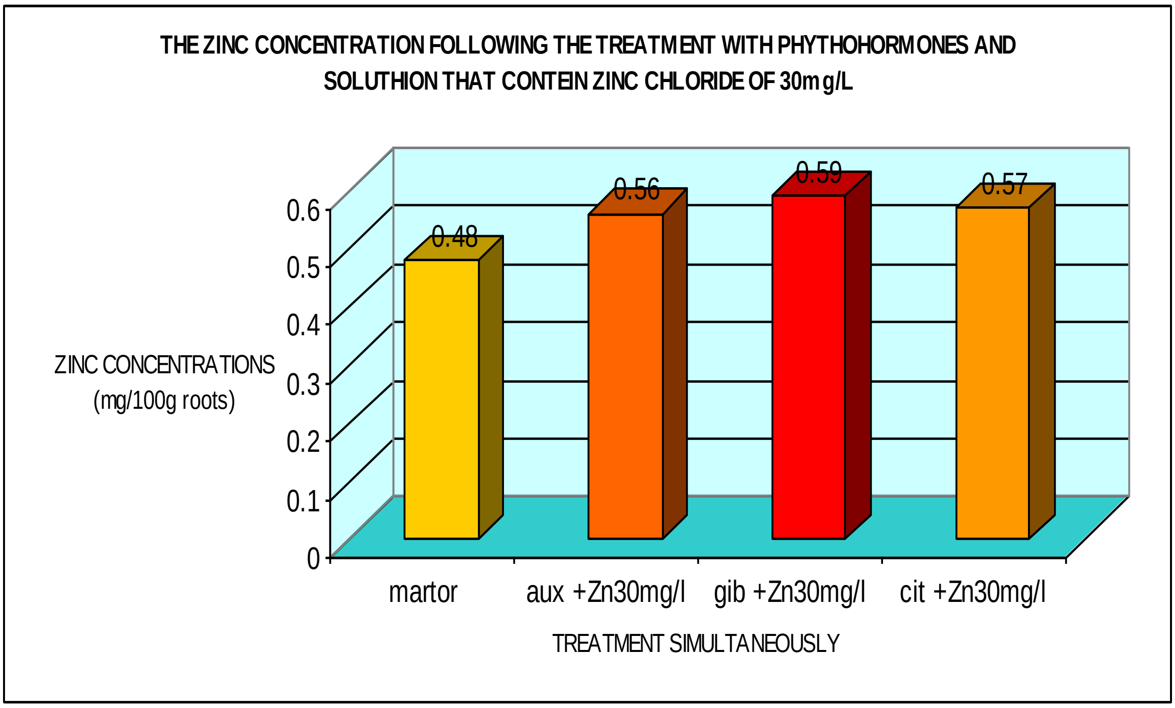
Results and discussions

In graph 2 we have shown the concentrations for Zn^{2+}, resulted following the spectrophotometric determinations. The graph contains average values for the three crops (years of study) taken for analysis.

The zinc content in sweet potato, as given in the literature, ranges between 0.22 – 0.63 mg/100 g of fresh vegetal material. From determinations one can remarked that following the treatment with phytohormones and solutions that contain zinc chloride of 30mh/L concentration the maximum value found in tuberous roots is not exceeded.

The accumulation of zinc is higher for nutritive solutions in comparison with the witness, but these values don't exceed the maximum concentrations existing without nutritional treatment. There is also remarked that for the three nutritional versions the accumulation is similar. Thus, it is little probable that, introducing into alimentation tuberous roots of sweet potato treated according to the above versions, the daily necessary requirement of 15mg zinc for human would be exceeded.

Graph 2



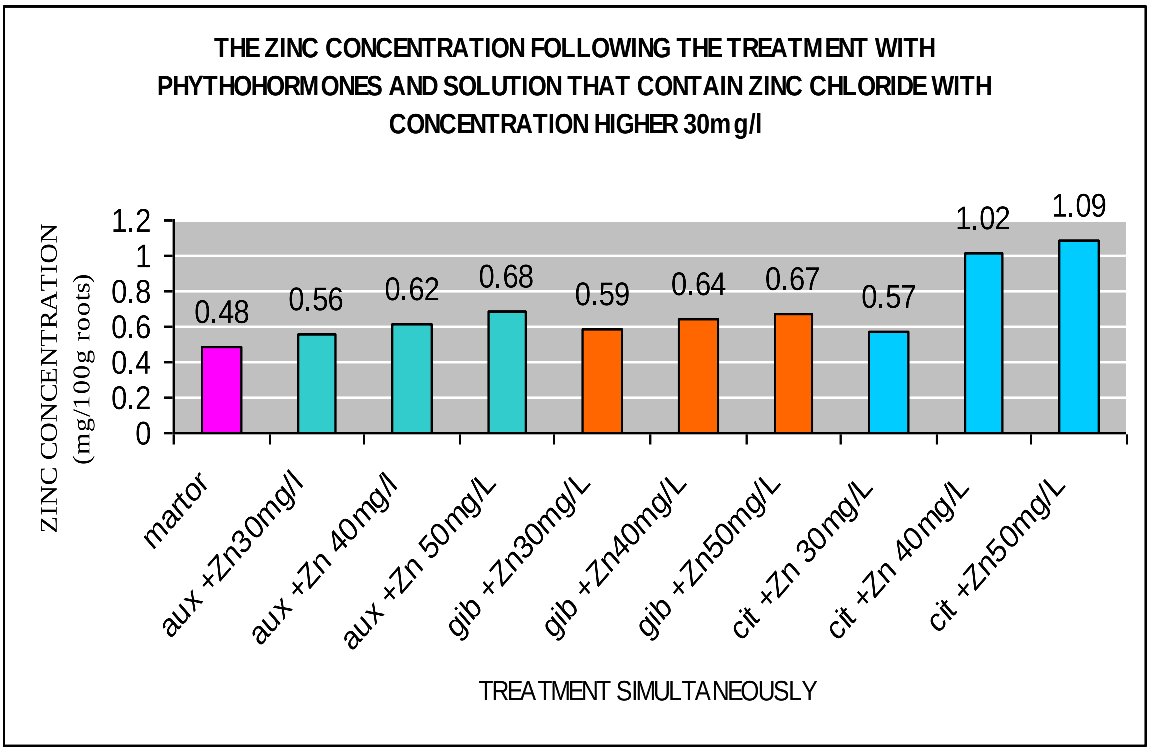
In the case of an average consumption of 500g sweet potato tuberous roots per day, the zinc contribution will be of maximum 3mg daily, thus we provide 20% from the necessary zinc requirement for the human adult. On the basis of rational diet, the exceeding of daily zinc requirement by consumption of tuberous roots cannot occur, thus the possibility of an excess of zinc and of some metabolic disorders specific to zinc excess in alimentation is excluded.

Due to the fact that over the concentration of 30mg/L $ZnCl_2$ in nutritive solution there is no observable variation of the values of concentration of bio-compounds determined, an analysis of zinc in sweet potato roots obtained over the concentration of 30mg/l $ZnCl_2$ in the nutritive solution imposes itself.

Following the analyses carried out for the phytohormonal and hydromineral versions with concentrations of $ZnCl_2$ higher than 30mg/L we have obtained the results shown in graph 3. The versions for the nutrition with three phytohomones and two concentrations of $ZnCl_2$ higher than 30mg/L, respectively 40mg/L and 50 mg/L, have been taken into consideration.

From the determinations carried out we observed that, proportionally with the increase of $ZnCl_2$ concentration in the nutritive solution, the zinc contents in sweet potato tuberous roots also increases. In the case of the treatment with kinetin, at the concentration of 50mg/L $ZnCl_2$ in nutritive solution, the quantity of Zn in tuberous roots is actually doubled.

Graph 3



If in the case of treatment with auxine and zinc or gibberellins and zinc with a concentration of 40mg/L, the zinc quantity in roots does not exceed the maximum value found in the literature (0.63 mg/100g fresh vegetal material); for concentrations of $ZnCl_2$ in nutritive solution of 50mg/L and the same phytohormones, the zinc quantity exceeds this maximum.

Conclusions

● The accumulation of zinc is higher for nutritive solutions in comparison with the witness, but these values do not exceed the maximum concentrations existing without nutritional treatment. Thus, it is little probable that the introduction in the diet of tuberous roots of sweet potato treated according to the above versions, to be exceeded the daily necessary requirement of 15 mg for human.

● On the basis of a rational diet, the excess of the daily zinc requirement through the consumption of tuberous roots cannot occur, thus the possibility of an excess of zinc and of some metabolic disorders specific to the excess of zinc into alimentation is excluded.

● Following the analyses carried out for the phytohormonal and hydromineral versions with concentrations of $ZnCl_2$ higher than 30mg/L it is observed that with the increase of

$ZnCl_2$ concentration in the nutritive solution, also the zinc contents in sweet potato tuberous roots increases.

● If in the case of treatment with auxine and zinc or gibberellins and zinc with concentration of 40mg/L, the zinc quantity in roots does not exceed the maximum value found in the literature (0.63 mg/100g fresh vegetal material), for concentrations of $ZnCl_2$ in nutritive solution of 50mg/L and the same phytohormones, the zinc quantity exceeds this maximum. But, even in this case, at an average consumption of 500g fresh tuberous roots a value of 25% from the daily necessary requirement of 15 mg zinc for humans is attained. In the case of the treatment with kinetin, at the concentration of 50mg/L $ZnCl_2$ in nutritive solution, the Zn quantity in tuberous roots is actually doubled.

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