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Department of General Chemistry, Medical University of Lublin
Medical Centre Galenus, Gniezno

KAZIMIERZ PASTERNAK, EWA BIELAK,
WŁODZIMIERZ BULIKOWSKI, WIESŁAW LINGAS

The influence of zinc and copper supplemenation in feed on the concentrations of certain metals in rats' skin

Current issues in the fields of ecology and hygiene are directing the interests of researchers in medicine and the biological sciences toward the elucidation of the causes of deficiency or excess of certain bioelements in the environment as well as in plant and animal organisms (13). Deficiency and excess of macro-and microelements can both lead to pathological changes mainly by affecting regulatory metabolic functions (13). Bioelement concentration changes can also affect the concentrations of other elements through certain interactions which, in effect, reduce or increase symptoms (8).

The purpose of the following paper was to indicate the influence of zinc and copper feed supplementation of the concentrations of magnesium, calcium and zinc in the skin of these animals.

MATERIAL AND METHODS

The experiments were conducted on male Wistar rats divided into groups of 6 animals each. Group I received 3000 mg/dm^3 zinc in their drinking water and group II received 100 mg/dm^3 (zinc chloride solution); group III received copper (300 mg/dm^3) and group IV – 100 mg/dm^3 (copper chloride solution). Group V served as control and the animals were given redistilled water to drink. All the animals were fed standard LSM feed and were watered *ad libitum*.

After 6 weeks the animals were sacrificed by ketamine administration, and while the internal organs were harvested, the skins were obtained for further study. The skins were stored at 0-4°C and later dried at 22°C with a relative humidity of 56% for 24h. In the next step, the skins were rinsed in Wacker drums in redistilled water at 25°C. Next the

skins were dried for 24h at 25°C where the rate of air movement was 0.2-0.8 m/s. After drying, the skins were cut into pieces and ashed at 550°C for 24h. The white ash, thus obtained, was dissolved in 25 ml HCl at the concentration of 0.2 M/dm^3 and elements were assayed by AAS method using an AAS-3 atomic absorption spectrophotometer (10). Magnesium and calcium were assayed in the presence of a strontium chloride buffer – magnesium at 285.2 nm with a 0.2 mm slit, calcium at 422.7 nm with a 0.5 mm slit. Zinc was assayed at 213.9 nm and a 0.2 mm slit, while copper at 324.8 nm and a 0.3 mm slit.

The results were analysed statistically using t-Student test with a value of $p<0.05$ considered significant.

RESULTS

According to the results, zinc administered at 300 mg/dm^3 and 100 mg/dm^3 caused a decrease in calcium levels in the animal skin (Tab. 1). The concentrations of magnesium and calcium in the tested groups were affected insignificantly.

Table 1. The impact of zinc on some metals concentrations (μg/g) in the skin of rats

Studied metals	Experimental concentrations of zinc		Control
	300 mg/dm^3	100 mg/dm^3	
Magnesium	192 17	184 29	197 16
Calcium	193 18*	130 19*	231 20
Zinc	69.6 0.7*	53.9 3.2	52.1 4.1
Copper	3.0 0.3	2.8 0.4	3.19 0.5

* Statistical significance $p < 0.05$.

Table 2. The impact of copper on some metals concentrations (μg/g) in the skin of rats

Studied metals	Experimental concentrations of copper		Control
	300 mg/ dm^3	100 mg/ dm^3	
Magnesium	153 14*	135 11*	197 16
Calcium	119 10*	159 15*	231 20
Zinc	27.9 6.1*	47.5 7.2	52.1 4.1
Copper	3.8 0.5*	3.3 0.4	3.19 0.5

* Statistical significance $p < 0.05$.

Copper administration caused a marked decrease in magnesium and calcium concentration in the skins at concentrations of 300 mg/dm^3 and 100 mg/dm^3 (Tab. 2).

At the higher copper concentration, zinc concentration was significantly reduced in the tested material, while at the lower concentration, the zinc concentration was insignificantly affected in comparison to controls.

DISCUSSION

The common occurrence of dermatological (especially allergic) disorders affecting tannery workers gave rise to interest in assaying bioelements in skin and hair follicles. It was then noticed that lower levels of calcium, magnesium and zinc (in atomopologrames) occur in individuals exposed to chromium (6). Further studies indicated that there are interrelations between chromium and magnesium in tanners as well as the protective action of magnesium in workers exposed to chromium (3). In the environment of the tannery one is exposed to toxic fungi (14), whose toxins can influence the concentrations of zinc and copper, which has been demonstrated on experimental animals (4).

Zinc and copper are microelements which have various important biological functions (7). These elements are used in therapy, in preparations that permit supplementation (11). They interact in the organism and also interact with other elements (12). The current observations are part of a series that may cast light upon the way that zinc and copper affect interactions with other elements in skin tissue. It must be noted that bioelement assays in skin and hair are good indicators of their presence in the whole organism (9). According to the literature, administration of zinc and copper prevent lead poisoning. Supplementation with zinc and copper is a prophylactic measure among tanners exposed to chromium (5). The biochemical actions of zinc and copper are mainly associated with oxidation and reduction (15). Administration of lead, zinc and copper to animals affects the tissue concentration of ascorbic acid, which may be associated with changes in the production of free radicals (1).

Our present studies have indicated that zinc and copper administered in the feed, influence bioelement concentrations (magnesium, calcium, zinc and copper) in the skin tissue of animals. This fact indicates the significance of zinc and copper in biological interactions of elements. It must be noted that copper had a more significant influence on all of the tested metals than had zinc administered at the same concentrations.

Further observations of bioelement assays conducted on animal skin tissue will permit the expansion of our knowledge concerning the subject of micro-and macroelement interactions.

CONCLUSIONS

1. Administration of zinc caused a decrease in calcium concentration and an increase in zinc concentration in the tested material.
2. Magnesium and copper concentrations in skin tissues of zinc treated animals were affected insignificantly.
3. Administration of copper caused a decrease in the concentrations of magnesium, calcium and zinc in the tested material with an increase in copper concentration.
4. Changes in the concentrations of the tested metals were dependent, to a certain extent, upon the concentration of the metal administered to the animals.

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SUMMARY

Zinc and copper, administered to the organism in excess can also influence the concentrations of other elements, and have a secondary influence on the processes that these elements regulate. The purpose of this experiment was to determine the influence of zinc and copper dietary supplementation on the concentrations of magnesium, calcium, zinc and copper in the rat's skin. The results showed that zinc supplementation caused a decrease in calcium concentration as well as an increase in zinc concentration in the tested materials. The concentrations of magnesium and copper changed insignificantly.

Copper supplementation caused a decrease in the concentration of magnesium, calcium and zinc but caused an increase in copper concentration. Changes in concentrations of the tested metals were dependent upon the concentrations of various metals added to the rat's diets.

Wpływ podawania cynku i miedzi w pożywieniu na stężenie niektórych metali w skórze szczurów

Cynk i miedź dostarczane do organizmu w nadmiarze mogą również wpływać na stężenia innych pierwiastków, a wtórnie i procesów przez nie regulowanych. Celem eksperymentu było określenie wpływu podawania cynku i miedzi w pożywieniu na stężenie magnezu, wapnia, cynku i miedzi w skórze szczurów. Przeprowadzone badania wykazały, że podawanie cynku powodowało spadek stężenia wapnia oraz wzrost stężenia cynku w badanym materiale. Stężenie magnezu i miedzi zmieniało się tylko nieznacznie. Podawanie miedzi powodowało zmniejszenie stężenia magnezu, wapnia i cynku, natomiast następował wzrost stężenia miedzi. Zmiany w stężeniach badanych metali były zależne od stężenia metalu podawanego szczurom w pożywieniu.