

# The chromium concentration in organs and tissues of rats fed a diet enriched in chromium

**E. Arkuszewska**

*Warsaw Agricultural University,  
Department of Animal Nutrition and Feed Science  
Ciszewskiego 8, 02-786 Warsaw, Poland*

## ABSTRACT

The concentration of chromium was determined in the tissues of growing rats after the addition to the diet of a yeast preparation with an increased chromium content (III). The experiment was carried out on 16 male Wistar rats divided in two groups and fed mixtures that were supplemented with chromium in the following quantities in the particular groups (in mg.kg<sup>-1</sup>): I-0.19; II-0.57. Supplementation of chromium did not affect its content in blood and *M. longissimus dorsi* but substantially increased it in the kidneys, liver, skin with hair, and pancreas.

KEYS WORDS: yeast, chromium, rat, organs, tissues

## INTRODUCTION

Chromium (III) is a trace element essential for humans (Jeejebhoy et al., 1977) and animals (Schwartz and Mertz, 1959), since as a component of glucose tolerance factor (GTF) it supports insulin action, participates in the regulation of hormone secretion, and in the metabolism of proteins, sugars and fats (Ducros, 1992; Anderson et al., 1996). Chromium deficit appears as a result of various stress situations such as transport, high animal density, or rapid growth rate, and also in young animals fed high energy diets resulting in full mobilization of insulin and depletion of chromium stores in the body (Moonsie-Shageer and Mowat, 1993).

In recent years, many investigations were performed on the effects of chromium (III) supplementation not only on animal health, performance and blood biochemical indices but also on the quality of animal products. Yeast

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<sup>1</sup> Corresponding author: e-mail: arkuszewska@alpha.sggw.waw.pl

preparations were used as the source of organic chromium, which has a higher biological activity than its inorganic forms (Anderson et al., 1996).

The aim of the present work was to determine the chromium concentration in organs and tissues of rats fed a diet supplemented with a yeast preparation containing an increased level of trivalent chromium.

## MATERIAL AND METHODS

The experiment was performed during 4 weeks on 16 male Wistar rats of initial mean body weight 62 g, divided in two groups. The animals were maintained in individual cages with free access to feed and water, in a room at 21°C, 50-70% humidity and 12 h/12 h light regimen. The animals were fed *ad libitum* a semi-synthetic (casein) diet according to NRC (1995) supplemented or not supplemented with yeast preparation Co-Factor III (Alltech, Nicholasville, Biotechnology Center, USA) of 0.5 g/kg<sup>1</sup>.

Feed intake and body weight were registered. At the end of the experiment the rats were anaesthetized, blood was collected and the longest muscle of the back (*M. longissimus dorsi*), the skin, liver, kidney, and pancreas were sampled. The chromium concentration in the diet and rat tissues was determined by atomic absorption spectrophotometry AAS (AOAC, 1980) after dry mineralization. The results were subjected to one-factorial variance analysis ANOVA, using the program Statgraphics 6.0 Plus.

## RESULTS AND DISCUSSION

The chromium concentration in the unsupplemented control (C) diet was 0.19 mg Cr/kg<sup>1</sup>, and in the yeast preparation, 757 mg Cr/kg<sup>1</sup>. Supplementation of diet C with 0.5 g yeast increased the Cr content by 0.380 mg/kg<sup>1</sup> up to 0.570 mg Cr/kg<sup>1</sup> in the experimental diet. Final body weight and feed/gain were significantly higher in rats fed the Cr-supplemented than the control diet (241 g and 2.5 g vs 222 g and 1.9 g, respectively).

Feeding the diet supplemented with the yeast preparation increased the chromium concentration in tissues and organs (Table 1).

The increase in blood serum and *M. longissimus dorsi* was rather small and non-significant, while in the kidney, liver, skin with hair, and pancreas it was greater and statistically significant. The results point to the accumulation of chromium in these organs when a diet containing 0.570 mg Cr(III)/kg<sup>1</sup> mixture is fed, and confirm the tendency towards deposition of heavy metals, including chromium, in the parenchymatous organs.

Table 1. Chromium concentration in rat (n=5) tissues, ng.g<sup>-1</sup> fresh tissue

| Tissue                      | Group              |                    | ANOVA |        |
|-----------------------------|--------------------|--------------------|-------|--------|
|                             | control (Cr-)      | experimental (Cr+) | SEM   | P      |
| Blood serum                 | 1.48               | 1.59               | 0.375 | NS     |
| <i>M. longissimus dorsi</i> | 6.28               | 8.55               | 0.621 | NS     |
| Kidney                      | 13.91 <sup>a</sup> | 18.46 <sup>b</sup> | 1.076 | 0.0211 |
| Liver                       | 2.35 <sup>a</sup>  | 4.27 <sup>b</sup>  | 0.520 | 0.0343 |
| Skin with hair              | 40.53 <sup>A</sup> | 60.41 <sup>B</sup> | 3.780 | 0.0043 |
| Pancreas                    | 25.77 <sup>A</sup> | 59.87 <sup>B</sup> | 1.820 | 0.0012 |

SEM- mean standard error, <sup>A,B</sup> - P<0.01; <sup>a,b</sup> - P<0.05

These results agree with those of Wallach (1985), Anderson et al. (1997), Hepburn and Vincent (2002). Feeding diets supplemented with chromium (III) in the form of chromium dinicotinic acid diglycine cysteine glutamic acid (GTF) in the amount of 5 mg.kg<sup>-1</sup> diet increased the chromium concentration in rat liver dry matter from 23 ng.g<sup>-1</sup> liver in the control group to 805 ng.g<sup>-1</sup> in experimental animals (Anderson et al., 1996).

The accumulation of chromium in skin and hair is in agreement with accumulation of heavy metals and other toxic substances in dead tissues such as feathers, hair, and horns, which is a way of eliminating toxins from the organism. Also Wallach (1985) found a higher content of chromium in hair and skin than in other tissues.

Among the analysed organs, the pancreas had the highest chromium concentration and responded in the most marked way to the chromium supplement. This is probably related to the metabolic function of chromium and its presence in the structure of GTF, which is synthesized and secreted by the pancreas. This may indicate that the pancreas is the target organ for chromium fed at physiological doses.

## CONCLUSIONS

The addition of trivalent chromium in the form of yeast at a dose of 380 ppb did not significantly affect the deposition of this element in the *M. longissimus dorsi*, while it increased chromium accumulation in the liver, kidneys, skin with hair, and pancreas.

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#### STRESZCZENIE

##### **Koncentracja chromu w tkankach szczurów po zastosowaniu dodatku do diet drożdży o podwyższonej zawartości chromu**

Określono koncentrację chromu w tkankach rosnących szczurów po zastosowaniu dodatku do diety preparatu drożdżowego o podwyższonej zawartości chromu (III). Doświadczenie przeprowadzono na 16 samcach szczurach rasy Wistar, podzielonych na 2 grupy i żywionych mieszankami, które różniły się zawartością chromu (w mg kg<sup>-1</sup>): I-0,19; II-0,570. Dodatek chromu nie wpłynął na jego koncentrację w krwi i *M. longissimus dorsi*, a zwiększył istotnie jego zawartość w wątrobie, nerkach, skórze i włosach oraz w trzustce.