

Testosterone and LH Seric Level Dynamics in Male Rats after Potassium Dichromate Intake (Two Generation Study)

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Abstract

The aim of this study was the evaluation of potassium dichromate impact on biochemical biomarkers for testicular function (serum testosterone and LH level) (two generations experiment). Males and females from F₀ generation were exposed to potassium dichromate three months before mating. F₁ generation was represented by male pups, resulted from F₀ generation, exposed to potassium dichromate *in utero*, in suckling period (via milk and water) and until sexual maturity. All the animals were divided in four groups: three experimental and one control, exposed to Cr VI through drinking water, as follows E₁: 25 ppm (LOAEL); E₂: 50 ppm; E₃: 75 ppm; control group received tap water without chromium content. The study was performed in compliance with national and international law regarding animal welfare and ethics in animal experiments. In male rats, from F₀ and F₁ generation, exposure to Cr VI determined: significant decrease of testosterone and significant increase of LH seric level in all experimental groups comparative to control one, indirectly, respectively, directly correlated to exposure level. Comparative to F₀ generation, in F₁ generation seric testosterone level was lower, significantly only in E₁ and E₃ groups, and LH seric level was significantly higher.

Keywords: chromium VI, male, rat, hormone, sex

1. Introduction

Chromium is the Earth's 21st most abundant element (about 122 ppm) and the 6th most abundant transition metal [1].

Chromium is a lustrous, brittle, hard metal. Its color is silver-gray and it can be highly polished. It does not tarnish in the air, when heated it burns and forms the green chromic oxide [2,3].

Chromium is unstable in oxygen presence, it immediately produces a thin oxide layer that is impermeable to oxygen and protects the metal below [2,3].

It can be found in nature in rocks or soil, water, plants, animals, volcanic dust and fumes [1]. Chromium has several oxidative states but the most common are trivalent and hexavalent [1].

Studies in the literature indicate that hexavalent chromium is more toxic than trivalent chromium [4]. Trivalent chromium is an essential nutrient and is necessary for the metabolism of sugars, cholesterol and fats [1,4]. Body possesses several mechanisms for reduction of chromium VI to chromium III. This detoxification leads to chromium III level increase.

The environmental and occupational sources of chromium include the following: environmental airborne emissions from chemical plants and incineration facilities, effluents from chemical plants, contaminated landfill, cement dust, road dust from catalytic converter erosion and asbestos brake, tobacco smoke, topsoil and rocks, occupational, welding of alloys or steel, leather tanning, chrome electroplating, chrome alloy production, textile manufacturing, paints/pigments, photoengraving, copier servicing, antifreeze, production of high-fidelity magnetic audio tapes, tattooing, wood preservatives,

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porcelain and ceramics manufacturing, glassmaking [1,3].

Chromium VI is actively transported across the cell membranes and is reduced via unstable reactive intermediate to chromium III [4]. Chromium chloride (III) is a common human exposure metal that is a carcinogen in mice, although it enters cells poorly, and is non-toxic and non-carcinogen in most biological systems [5].

The aim of this study was the evaluation of potassium dichromate impact on biochemical biomarkers for testicular function (seric testosterone and LH level) (two generations study).

2. Materials and methods

The study was carried out on two generation male rats. F₀ generation was represented by 28 White Wistar male rats divided in three experimental and control group. Rats were exposed to potassium dichromate for three months before mating as followed: E₁: 25 ppm (LOAEL) [1]; E₂: 50 ppm (2 x LOAEL); E₃: 75 ppm (3 x LOAEL); control group received tap water without chromium content.

After mating with female rats exposed to potassium dichromate for the same period of time

and Cr VI level all males were sacrificed following protocols and ethical procedures and sex hormone levels were determined by Tody Laboratories Bucharest (ISO 17025).

Female rats continued to be exposed during gestation and lactation period to same levels of Cr VI. After weaning, male pups (F₁ generation) were separated from female pups. Male pups continued to be exposed to same levels of Cr VI through drinking water for three more months (until sexual maturity). After this period of time seven rats from every group were sacrificed following protocols and ethical procedures and seric hormone levels were determined by Tody Laboratories Bucharest (ISO 17025).

All the animals were provided free access to food and water.

The study was performed in compliance with national and international law regarding animal welfare and ethics in animal experiments: 143/400/2002; 471/2002; 205/2004; 206/2004; 9/2008; 86/609/CEE [6-11].

The results were statistically analyzed by Anova method and Student test.

3. Results and discussion

The results are summarized in table 1 and figure 1.

Table 1 Seric LH and testosterone level (ng/ml) in F₀ and F₁ generation

Specification	Groups	F ₀			Groups	F ₁			F ₀ /F ₁ (%)
		X±Sx	S.D.	CI 95%		X±Sx	S.D.	CI 95%	
Testosterone	C	3.55±0.52	1.36	0.75	C'	3.10±0.01	0.01	0.02	- 12.67 ^{ns}
	E ₁	1.85±0.23*	0.61	0.75	E' ₁	1.25±0.01**	0.01	0.02	- 32.43*
	E ₂	1.12±0.44***	1.17	0.75	E' ₂	0.88±0.01**	0.02	0.02	- 21.42 ^{ns}
	E ₃	0.56±0.08**	0.22	0.75	E' ₃	0.47±0.01**	0.02	0.02	- 30.35*
LH	C	4.96±0.10	0.27	0.45	C'	4.73±0.08	0.21	0.08	- 4.63 ^{ns}
	E ₁	5.88±0.14***	0.36	0.45	E' ₁	6.22±0.01**	0.01	0.08	+5.78*
	E ₂	6.75±0.27***	0.72	0.45	E' ₂	7.34±0.01**	0.01	0.08	+8.70*
	E ₃	7.07±0.29***	0.78	0.45	E' ₃	7.69±0.01**	0.01	0.08	+8.70*

E/C: ^{ns} – not significant

* – p<0.05

** – p<0.0001

*** – p<0.01

In F₀ generation all exposed groups (E) presented significant increase (p<0.0001) of seric LH concentration comparative to control (C) one (E₁/C: +18.54%; E₂/C: +36.08%; E₃/C: +42.54%), directly and significantly correlated to exposure level, excepting, not significantly (p>0.05), at 1.5 times increased dose (E₂/E₁: +14.79%, p<0.05; E₃/E₂: +4.74%, p>0.05; E₃/E₁: +20.23%, p<0.01).

Seric testosterone level decreased significantly in all individuals, from F₀ generation, exposed (E) to potassium dichromate, comparative to control (C), being highly significant (p<0.0001) only at 75 ppm Cr VI (E₁/C: -47.88%, p<0.05; E₂/C: -68.45%, p<0.01; E₃/C: -84.22%) and inversely correlated to exposure level (E₂/E₁: -39.45%, p>0.05; E₃/E₂: -50%, p>0.05), significantly (p<0.05) only when exposure level increased from 25 to 75 ppm Cr VI (E₃/E₁: -69.72%, p<0.05).

In F₁ generation all experimental groups (E') had significantly (p<0.0001) higher seric LH level comparative to control group (C') (E'₁/C': +31.50%; E'₂/C': +55.17%; E'₃/C': +62.57%). LH level in exposed groups was directly and significantly (p<0.0001) correlated with exposure level (E'₂/E'₁: +18%, E'₃/E'₂: +4.76%, E'₃/E'₁: +23.63%).

Comparative to males from F₀ generation, LH seric level was significantly (p<0.05) higher in

F₁ generation (E'₁/E₁: +5.78%; E'₂/E₂: +8.70%; E'₃/E₃: +8.70%).

In E' groups from F₁ generation seric testosterone level realized a significant (p<0.0001) decrease comparative to C' group (E'₁/C': -59.67%; E'₂/C': -71.61%; E'₃/C': -87.42%). Hormone level decrease was indirectly, significantly (p<0.0001) correlated to exposure level (E'₂/E'₁: -29.6%, E'₃/E'₂: -55.69%, E'₃/E'₁: -68.8%).

Comparative to F₀ generation seric testosterone level in F₁ generation was lower, significantly (p<0.05) only in E'₁ and E'₃ groups (E'₁/E₁: -32.43%, p<0.05; E'₂/E₂: -21.42%, p>0.05; E'₃/E₃: -30.35%, p<0.05).

LH seric level, in F₀ and F₁ generations, was higher than the physiological limit (Ph) (0.5 ng/ml) [12] in all groups but more evident in E and E' groups (C/Ph: +892%, C'/Ph: +846%; E₁/Ph: +1076%; E₂/Ph: +1250%; E₃/Ph: +1314%; E'₁/Ph: +1144%; E'₂/Ph: +1368%; E'₃/Ph: +1438%).

In both generations, testosterone seric level was slightly higher (C/Ph: +42%, C'/Ph: +24%) than the maximum physiological limit (2-3 ng/ml) [12] in C and C' groups but evidently lower in E and E' groups (E₁/Ph: -26%; E₂/Ph: -55.2%; E₃/Ph: -77.6%; E'₁/Ph: -50%; E'₂/Ph: -64.8%; E'₃/Ph: -84.4%).

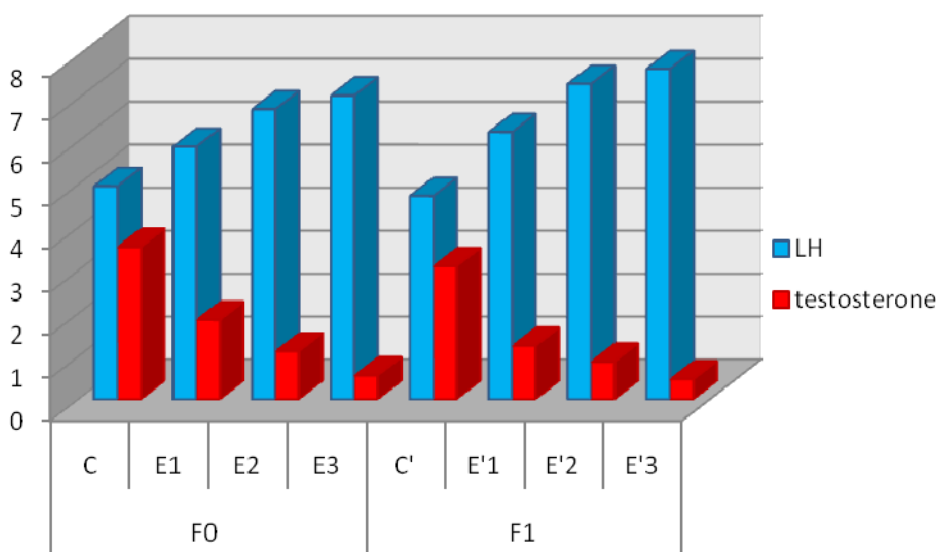


Figure 1 Seric LH and testosterone level dynamics in F₀ and F₁ generations

Results regarding LH seric level after potassium dichromate exposure are in accordance with other authors: Ernst and Bonde [13], Li *et al.* [14] but are controversial to Chandra *et al.* [15] results. Results related to seric testosterone level increase are similar to those obtained by Ernst and Bonde [13], Yousef *et al.* [16] and Chandra *et al.* [15].

4. Conclusions

The exposure of adult male rats to potassium dichromate (Cr VI) in drinking water (25, 50 and 75 ppm Cr) along of two generations determined:

- ↪ significant increase of seric LH level comparative to control group and in direct, correlation to exposure level, in F₀ and F₁ generations;
- ↪ significant decrease of seric testosterone level comparative to control group and in inverse correlation to exposure level, in F₀ and F₁ generations;
- ↪ significant increase of LH seric level in F₁ generation comparative to F₀ generation;
- ↪ decrease of testosterone seric level in F₁ generation comparative to F₀ generation, significant only in E₁ and E₃ groups.

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