HVM BIOFLUX

Human & Veterinary Medicine
International Journal of the Bioflux Society

Effect of potassium dichromate intake on water consumption and toxic amount intake, in female rats, *Rattus norvegicus* (exposure on three generations)

[1]Snejana Petrovici, [1]Alexandra Trif, [2]Milca Petrovici, [1]Eugenia Dumitrescu, [1]Romeo T. Cristina, [1]Camelia Tulcan

[1]Faculty of Veterinary Medicine, Timişoara, Romania, EU;
[2]Faculty of Chemistry, Biology, Geography, Timişoara, Romania, EU.
Corresponding author: Snejana Petrovici, petrovicisnejana@yahoo.com

Abstract. Material and methods: The study was carried out on three generations of female rats, each generation comprising 28 white Wistar adult female rats, divided in three experimental (E) groups, exposed to 25 ppm Cr – LOAEL (E_1), 50 ppm Cr (E_2), 75 ppm Cr (E_3) and one control (C) group - tap water. Results: It pointed out significant decrease of water daily mean consumption in experimental groups comparative to C group, inversely, significantly correlated with the exposure level, in F_0, F_1 and F_2 generations, the mean daily water intake decreasing with the increase of the number of generations exposed, the lowest being found in the case of F_2 generation, followed by F_1 generation and F_0, the differences being insignificant. Also hexavalent chromium intake was calculated, F_2 generation having the poorest appetite for water, received the smallest amount of toxic, but yet not undermining the gravity of exposure in F_2 generation, due to parental exposure factors.

Key words: chromium, females, rat, water.

Rezumat. Material şi metodă: Studiul a fost efectuat pe trei generaţii de femele de şobolan, fiecare generaţie având 28 de femele de şobolan adulte din rasa White Wistar, împărţită în trei grupuri experimentale (E), expuse la 25 ppm Cr – LOAEL (E_1), 50 ppm Cr (E_2), 75 ppm Cr (E_3) şi un grup martor (C) – apă de robinet. Rezultate: au dezvăluit scăderea semnificativă a consumului mediu zilnic de apă la loturile experimentale comparativ cu grupul martor, în corelaţie inversă, semnificativ, cu nivelul de expunere, la generaţiile F_0, F_1 şi F_2, media zilnică a aportului de apă scăzând odată cu creşterea numărului de generaţii expuse, cea mai scăzută fiind întâlnită în cazul generaţiei F_2, urmată de F_1 şi F_0, cu diferenţe nesemnificative. De asemenea, a mai fost calculat aportul de crom hexavalent, generaţia F_2 având cel mai scăzut apetit pentru apă, primind astfel cel mai puţin toxic, nesubestimând însă cu toate acestea gravitatea expunerii în cazul generaţiei F_2, datorată factorilor parentali de expunere.

Cuvinte cheie: crom, femele, şobolan, apă.

Introduction. Chromium compounds are found in the environment, due to erosion of chromium containing rocks and can be distributed by volcanic eruptions in food and water. Metals being non-biodegradable, persist in the environment for a long period, causing serious ecotoxicological problems (Mclachlan et al 2008; Coşier & Petrescu-Mag 2008; Petrovici et al 2010; Trif et al 2010).

Hexavalent chromium is an important reproductive and developmental toxicant, having major side effects in humans and animals. It develops important irreversible perturbances (in short and in long term exposure), covering both the structural and functional levels of the organism (Toxicology Profile for Chromium, U.S. EPA, 2001; Oliveira et al 2010).

Material and Method. The present study was carried out on three generations of female rats (White Wistar) as follows: 28 adult female rats, exposed three months to potassium dichromate, mated with males exposed also three months to potassium dichromate represented the F_0 generation. The exposure of F_0 female rats continued during pregnancy and lactation period. The F_1 generation females were exposed *in utero*, in suckling period, and after that via drinking water until sexual maturity. They were mated with other males exposed to the same doses of potassium dichromate. The exposure followed during pregnancy and lactation, the resulting female offspring, belonging to F_2 generation was exposed until sexual maturity. So, the F_2 generation was exposed *in utero,* during suckling period and until sexual maturity. In F_0, F_1 and the F_2 generation, water consumption (in milliliters) was evaluated at sexual maturity in each case of exposure, after being calculated the daily intake, presented as a mean, by dividing the period to the number of days.

All studied generations were structured in one control group, C, that received tap water, not containing chromium, and three experimental groups: E_1: 25 ppm Cr VI – LOAEL for reproductive function (Toxicology Profile for Chromium, U.S. EPA, 2001), E_2: 50 ppm (2 X LOAEL), and E_3: 75 ppm (3 X LOAEL).

Also the intake of hexavalent chromium (from the amount of potassium dichromate consumed) was evaluated.

The results were processed by ANOVA and Student's test.

All assays on animals were conduced in accordance with present laws regarding animal welfare and ethics in animal experiments (Directive 86/609 EEC/1986; Romanian Law 205/2004; Romanian Law 206/2004; Romanian Law 471/2002; Romanian Law 9/2008; Romanian Order 143/400).

Results. The values of the daily mean water intake in the case of three generations exposed to potassium dichromate are presented in Table 1 and Figure 1.

The dynamics of water consumption for the F_0, F_1 and F_2 generations was registered from the time when the pups started to consume by their own forages and water. We estimated the mean water daily intake from that moment and until sexual maturity.

Table 1

Mean daily water consumption in the case of three generation female rats exposed to potassium dichromate (25, 50 and 75 ppm CrVI)

		F_0 generation	F_1 generation	F_2 generation
C	(X±Sx)	18.48±0.01	17.87±0.01	17.95±0.01
	S. D.	0.01	0.01	0.01
	C.L.	0.01	0.01	0.01
E_1	(X±Sx)	15.33±0.01	14.32±0.01	12.41±0.01
	S. D.	0.01	0.01	0.01
	C.L.	0.01	0.01	0.01
E_2	(X±Sx)	14.98±0.01	13.03±0.01	11.32±0.01
	S. D.	0.02	0.01	0.01
	C.L.	0.01	0.01	0.01
E_3	(X±Sx)	10.33±0.01	9.90±0.01	8.75±0.01
	S. D.	0.01	0.01	0.01
	C.L.	0.01	0.01	0.01
X_E	(X±Sx)	13.55±1.61	12.42±1.31	10.83±1.08
	S. D.	2.79	2.27	1.88
	C.L.	3.31	3.31	3.31

SD=standard deviation, CL=limits of confidence, X= mean, Sx= the sample standard deviation of the variable "x", X_E = mean value for all experimental groups.

Generation F_0

Mean water daily consumption decreased, significantly ($p<0.01$) in the case of exposed groups, comparative to control group (E_1/C: -17.04%, E_2/C: -18.93%, E_3/C: -44.10%), inversely correlated, significantly ($p<0.001$), with the exposure level: E_2/E_1: -2.28%, E_3/E_2: -31.04%, E_3/E_1: -32.61%.

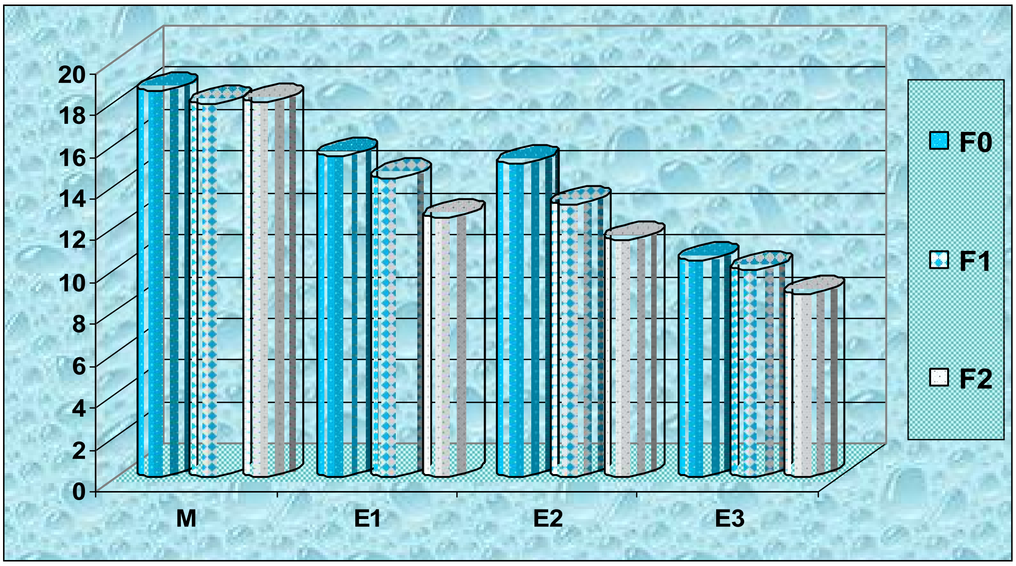

Figure 1. Water main daily consumption in three generations exposed to potassium dichromate.

Generation F_1
In F1 generation, the mean water daily consumption decreased significantly ($p<0.001$) in exposed groups, comparative to control group (E_1/C: -19.86%, E_2/C: -27.08%, E_3/C: -44.59%), inversely correlated, significantly ($p<0.001$), with the exposure level: E_2/E_1: -9.00%, E_3/E_2: -24.02%, E_3/E_1: -30.86%.

Generation F_2
The mean daily water consumption decreased significantly ($p<0.001$) after the exposure of experimental groups to potassium dichromate, as comparative to control group (E_1/C: -30.86%, E_2/C: -36.93%, E_3/C: -51.25%), inversely correlated, significantly, ($p<0.001$), with the exposure level: E_2/E_1: -8.78%, E_3/E_2: -22.70%, E_3/E_1: -29.49%.

❖ ***Mean daily intake of potassium dichromate***

Based on the mean daily water consumption, we estimated the actual intake of potassium dichromate (Cr VI), respectively the amount (mean/day/experiment) received by the organism in each case of exposure (generation exposed).

Thereby:

- Exposure on F_0 generation: mean water consumption: 13.55 ml;
- Exposure on F_1 generation: mean daily water consumption: 12.42 ml;
- Exposure on F_2 generation: mean daily water intake: 10.83 ml.

Potassium dichromate administration:

- 25 ppm = 0.05 g potassium dichromate;
- 50 ppm = 0.1 g potassium dichromate; ⇨ X_E = 35 ppm = 0.1 g potassium dichromate
- 75 ppm = 0.15 g potassium dichromate.

Example of operation:
35 ppm.......0.1 g.......1ml
X (ppm)......Y (g)........16.71 ml.

The intake of potassium dichromate was decreased in the case of F_2 generation because of the progressive decrease of appetite for water in proportion as the exposures continued on following generations.

The low level of potassium dichromate in the case of F_2 generation, yet does not undermine it's negative effect, which is more severe than in the case of the other exposed generations (F_1 and F_0), because of the generational exposure effect, exposure during *in utero* period, suckling, added at the parent's intoxication and the one of the previous generation.

Table 2

Potassium dichromate intake

Exposure period	ppm potassium dichromate	potassium dichromate (g)
generaţia F_0	474.25	1.355
generaţia F_1	434.7	1.242
generaţia F_2	379.05	1.083

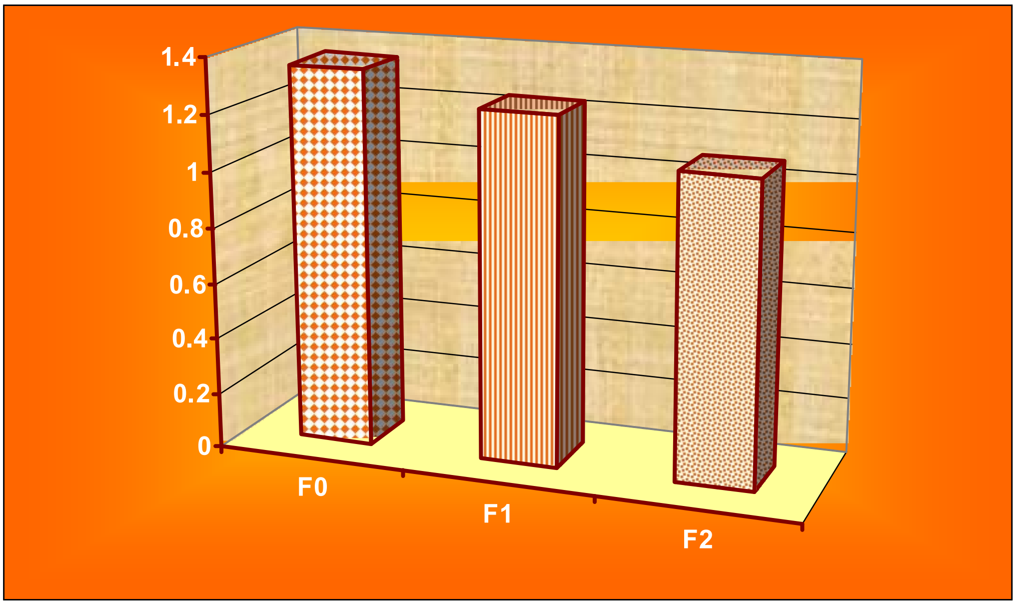

Figure 2. Potassium dichromate intake (g/day/experiment) depending on duration of exposure (three different generations).

Discussion. Following generational (F_0, F_1 and F_2) exposure to potassium dichromate, the mean daily water intake decreased with the increase of the number of generations exposed, the lowest being found in the case of F_2 generation (X_E: 10.83 ml), followed by F_1 generation (X_E: 12.42 ml) and F_0 (X_E: 13.55 ml), X_EF_1:/X_EF_0: -8.33%, X_EF_2/X_EF_1: -12.80%, X_EF_2/X_EF_0: -20.07%, the differences being insignificant ($p>0.05$).

The results regarding the decrease of water intake/consumption are in accordance with those found by other authors: Oliveira et al (2010), Soudani et al (2010) and Mclachlan et al (2008), in the case of potassium dichromate exposure, but in other doses, respectively 125 and 250 ppm.

Our studies were designed to establish whether there is a negative impact of low doses (as 25 ppm, LOAEL for reproductive function) on water intake, revealing the toxicity of potassium dichromate at low doses, which are accessible to both animals and humans.

The fact that the ingested amount of potassium dichromate was the lowest in F_2 generation is due to the decrease of appetite for water but does not undermine the importance of this exposure, F_2 generation being the most affected generation, followed by F_1 and F_0, because of the parental factor that is involved.

Conclusions. Chromium intake, as potassium dichromate, in drinking water (25, 50 and 75 ppm), determined in female rats from parental generation (F_0): significant decrease of water daily mean consumption in experimental groups comparative to control group, inversely, significantly correlated with the exposure level.

Chromium intake, as potassium dichromate, in drinking water (25, 50 and 75 ppm), determined in female rats from F_1 generation: significant decrease of daily mean water consumption in experimental groups comparative to control group, inversely, significantly correlated with the level of exposure.

Chromium intake, as potassium dichromate, in drinking water (25, 50 and 75 ppm), determined in female rats from F_2 generation: significant decrease of water daily mean consumption in experimental groups comparative to control group, inversely, significantly correlated with the exposure level.

The mean daily water intake decreased with the increase of the number of generations exposed, the lowest being found in the case of F_2 generation, followed by F_1 generation and F_0, the differences being insignificant ($p>0,05$).

The decrease of the appetite for water, pointed out the decrease of potassium dichromate intake, inversely correlated with the exposure level.

References

Coşier V., Petrescu-Mag I. V., 2008 Microbial biotechnology for remediation of aquatic habitats polluted with chromium. AACL Bioflux **1**(2):153-159.

Mclachlan J. A., Simpson E., Martin M., 2006 Endocrine disrupters and female reproductive health. Best Practice & Research Clinical Endocrinology & Metabolism **20**(1):63-75.

Oliveira H., Spano M., Guevara M. A., Santos T. M., et al, 2010 Evaluation of in vivo reproductive toxicity of potassium dichromate in male mice. Experimental and Toxicologic Pathology **62**(4):391-404.

Petrovici S., Trif A., Petrovici M., Cristina R. T., Tulcan C., 2010 Consequences of potassium dichromate intake on proteic profile in female rats, *Rattus norvegicus* (six months exposure). ABAH Bioflux **2**(1):11-14.

Soudani N., Sefi M., Amara I. B., Boudawara T., Zeghal N., 2010 Protective effects of selenium (Se) on chromium VI induced nephrotoxicity in adult rats. Ecotoxicology and Environmental Safety **73**(4):671-678.

Trif A., Petrovici S., Dumitrescu E., Petrovici M., 2010 Dynamics of female sexual hormones in F_1 generation female rats (*Rattus norvegicus*), exposed to potassium dichromate (Cr VI). ABAH Bioflux **2**(1):15-19.

*** Directive 86/609 EEC from 24.11.1986, for protection of animals used in scientific purposes and other scientific means, http://ec.europa.eu/food/fs/aw/aw_legislation/scientific/86-609-eec_en.pdf

*** Romanian Law 205/26.05.2004 regarding animal protection.

*** Romanian Law 206/27.05.2004 regarding work in scientific research, technological development and inovation

*** Romanian Law 471/9.07.2002 for O.G. nr. 37/2002 approval for animal protection when used in scientific purpuses and other experimental means.

*** Romanian Law 9/11.01.2008 for modification and addendum of 205/2004 Law regarding animal protection.

*** Romanian Order 143/400 for approval of instruction for housing and attendance of animals used in scientific purposes and other scientific means.

*** Toxicology Profile for Chromium, U.S. EPA, 2001 http://www.epa.gov

Received: 30 May 2010. Accepted: 15 June 2010. Published online: 18 June 2010.
Authors:
Snejana Petrovici, Faculty of Veterinary Medicine, Timişoara, Romania, Calea Aradului no 119, 300645, petrovicisnejana@yahoo.com
Alexandra Trif, Faculty of Veterinary Medicine, Timişoara, Romania, Calea Aradului no 119, 300645, al_trif@yahoo.com
Milca Petrovici, Faculty of Chemistry, Biology, Geography, Romania, Timişoara, Pestalozzi Street no 16A, 300115, milcapetrovici@yahoo.com
Eugenia Dumitrescu, Faculty of Veterinary Medicine, Timişoara, Romania, Calea Aradului no 119, 300645, cris_tinab@yahoo.com
Romeo Teodor Cristina, Faculty of Veterinary Medicine, Timişoara, Romania, Calea Aradului no 119, 300645, rtcristina@yahoo.com
Camelia Tulcan, Faculty of Veterinary Medicine, Timişoara, Romania, Calea Aradului no 119, 300645, camelia_tulcan@yahoo.com
How to cite this article:
Petrovici S., Trif A., Petrovici M., Dumitrescu E., Cristina R. T., Tulcan C., 2010 Effect of potassium dichromate intake on water consumption and toxic amount intake, in female rats, *Rattus norvegicus* (exposure on three generations). HVM Bioflux **2**(1):25-30.