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Research Article

Evaluation of the Toxicity of Cadmium Sulfate on the Average Weight of Internal Organs in Rats Wistar

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Abstract: The pollution of the ecosystem by industrial effluents and sewage, results in the contamination of air, food with toxic agents such as heavy metals which constitute a significant risk of public health. Six (6) lots of male and female Wistar rats were formed. These rats were contaminated with cadmium sulphate by daily gavage for 30 days at different doses respectively 0; 4; 5; 6.66; 10 and 20 mg / kg body weight. At the end of the experiment, the animal organs were extracted, cleaned with distilled water and weighed. Cadmium induced a significant decrease ($p<0.05$) in organ weights compared with controls. Cadmium sulphate has generally resulted in atrophy of the vital organs. However, he did not act on the lungs given the mode of administration (ingestion).
Keywords: cadmium sulfate, spleen, liver, kidneys and atrophy.

INTRODUCTION

Cadmium (Cd) is a highly toxic heavy metal (Pirarat *et al.*, 2008). It has an effect on the whole body with a half-life between 15 to 30 years. Long-term environmental exposure to Cd acts as a carcinogen in humans (Achanza *et al.*, 2001; Luevano and Damodaran., 2014). Depending on the metal exposure conditions (diet or smoking), 5% of the ingested cadmium is absorbed by the gastrointestinal tract in the form of salt, while 90% of the inhaled cadmium is absorbed by the pulmonary route (Jarup, 2002). Smoking is a major contributor to cadmium (approximately 1 µg per cigarette) (Pascal *et al.*, 2010).

After ingestion, cadmium accumulates in target organs such as the renal cortex and liver (Pascal *et al.*, 2010). Average daily intakes are around 10 to 35 µg in non-smoking adults (Pascal *et al.*, 2010, Koffi *et al.*, 2014). These exposures to cadmium cause pathologies in various organs including the testes, the brain, the nervous system (Pirarat *et al.*, 2008), the liver, the kidney, the spleen (Diaby *et al.*, 2016).

Animal and organ weight were used as a health biomarker according to a study conducted by Randa *et al.*, (2012). This is why the aim of this study is to evaluate the effect of cadmium sulphate on the average weight of organs (kidneys, liver and spleen) in Wistar rats.

MATERIAL AND METHODS

The biological material consists of male and female Wistar strain rats weighing 106 ± 6 g and 8-12 weeks old. The rats were placed in cages lined with wood chip litter and acclimatized two weeks before the start of handling. They were fed with pellets and watered with tap water. The room was well ventilated and lit 12 hours a day.

The cadmium sulphate used for the tests was dehydrated salt, MERCK brand, with a serial number of 1.02027.0100.

The animals were tagged batchwise within each lot to identify them during the experiment. Twelve (12) batches of five (5) rats were constituted including 6 male and 6 female batches. Lot 1 (males) and lot 1 (females) constituted the control batches where the animals received distilled water by gavage (1 ml / day). Lots 2, 3, 4, 5 and 6 of each sex received by gavage respectively 1/50 th, 1/40 th, 1/30 th, that is 1/20 th and 1/10 th of the LD50 (200 mg / kg pc) of the solution of

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cadmium sulphate which are respectively 4; 5; 6.66; 10 and 20 mg / kg body weight (bw). The duration of treatment of rats with cadmium sulphate was 30 days (Layachi and Kechrid, 2012). And the volume administered was 1ml per day each morning during the treatment period. The rats were sacrificed by decapitation after the period of exposure to cadmium sulphate.

STATISTICAL ANALYSIS

The statistical tests and the graphs were made thanks to a computer software of statistical analyzes named grapPhad.Prism.V5.01. The data was analyzed with ANOVA One-Way. The nonparametric Dunnett test was used to compare the weight variance of the control rats with that of the other lots. The difference between two variances was significant, if p <0.05.

RESULTS

Action of cadmium sulphate on the average weight of organs

Effect of cadmium toxicity on liver weight

Effect of cadmium sulphate on mean liver weight in male Wistar rats

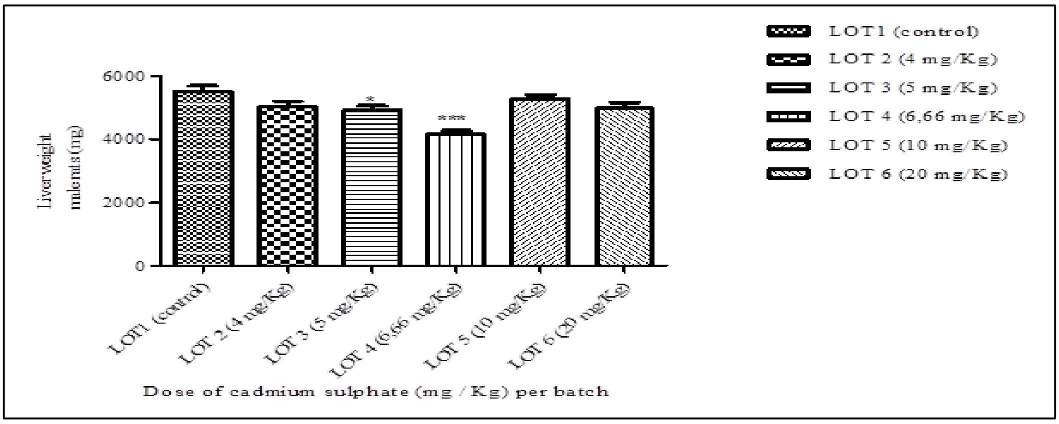

Figure 1: Effect of cadmium sulphate on liver weight in male Wistar rats

Figure 1 shows the effect of cadmium toxicity on mean liver weight in male rats. Compared with controls (5524.66 mg ± 370.54), cadmium resulted in a significant decrease in mean liver weight in treated rats, namely: 4925.00 mg ± 295.39 for the 5 mg / kg dose; 4170.50 ± 224.15 for the dose 6.66 mg / kg. However, the other doses showed a non-significant decrease of 5030.66 mg ± 392.88 for the 4 mg / kg dose; 5272.33 mg ± 293.50 for the dose 10 mg: kg; 4984.00 mg ± 408.28 for the dose 20 mg: kg of cadmium. This effect of cadmium toxicity is not dose-dependent.

Effect of cadmium sulphate on mean liver weight in female Wistar rats

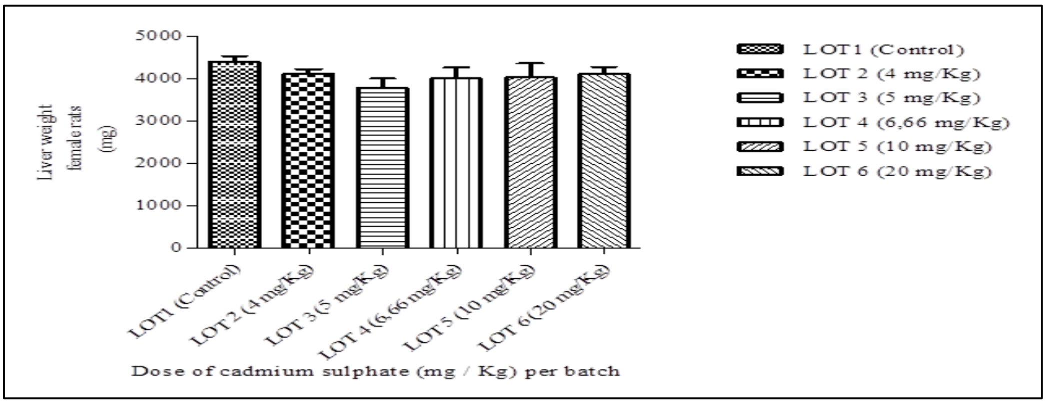

Figure 2: Effect of cadmium sulphate on liver weight in Wistar rats females

In females, Figure 2 shows the effect of cadmium on mean liver weight. The treated lots (4108.25 mg ± 242.31 for the dose 4 mg / kg, 3778.25 mg ± 474.018 for the dose 5 mg / kg, 3998.2 mg ± 570.29 for the dose 6.66 mg / kg kg, 4021.00 mg ± 733.53, for the dose 10 mg / kg, 4095.00 mg ± 392.77 for the dose 20 mg / kg) showed a non-significant decrease in mean liver compared to controls 4397.4 mg ± 275.49. This decrease is not dose-dependent.

Effect of cadmium toxicity on mean kidney weight

Effect of cadmium sulphate on mean kidney weight in male Wistar rats

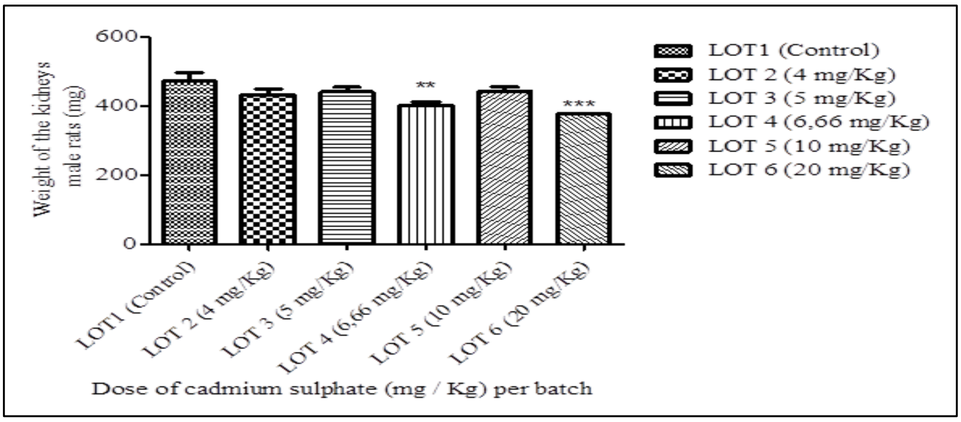

Figure 3: Effect of cadmium sulphate on kidney weight in male Wistar rats

The toxicity of cadmium on the average weight of the kidneys is shown in Figure 3. In fact, cadmium resulted in a significant decrease in the average weight of the kidneys (403.33 mg ± 19.39 for the dose 6.66 mg / kg 376.66 mg 4.50 for the 20 mg / kg dose) compared to controls (472.8 mg ± 54.12). However, at the other doses, this decrease is not significant (434.25 mg ± 35.17 for the dose 4 mg / kg, 441.40 mg ± 29.97 for the dose 5 mg / kg, 443.75 mg ± 27, 14 for cadmium dose of 10 mg / kg). The observation is made that the effect is not dose-dependent.

Effect of cadmium sulphate on mean kidney weight in female Wistar rats

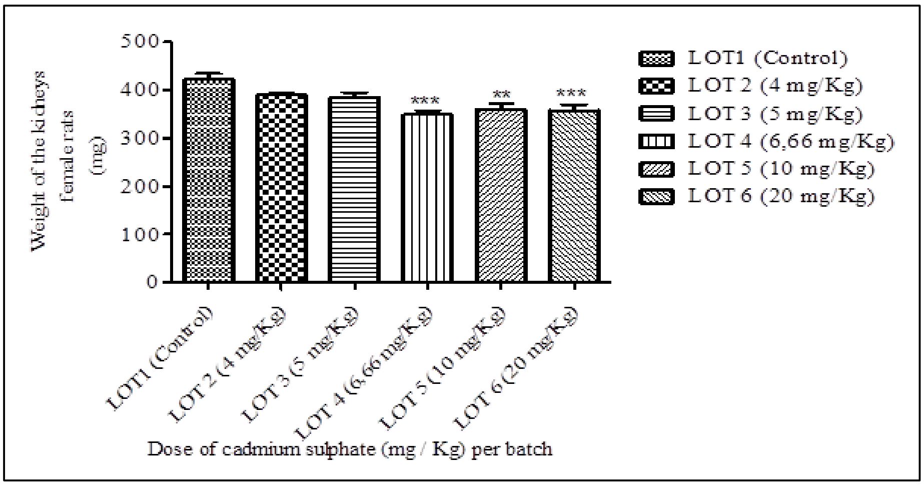

Figure 4: Effect of cadmium sulphate on kidney weight in female Wistar rats

Figure 4 shows the effect of cadmium on mean weight in females treated at different doses. Compared with controls (422.4 mg ± 26.93), cadmium resulted in a significant decrease in mean kidney weights observed at doses of 6.66 mg / kg, 10 mg / kg; 20 mg / kg which have respective average weight 348.8 mg ± 20.92; 360.60 mg ± 26.62; 358.2 mg ± 27.47.

With regard to the doses 4 mg / kg with average weight 390.5 mg ± 9.11 and 5 mg / kg with average weight 385.75 mg ± 22.57, the decrease is not significant.

In both males and females, the effect of decrease is slight at low doses and considerable at high doses. At the same time, it is not dose-dependent.

Action of cadmium sulphate on mean rat spleen weight

Effect of cadmium sulphate on mean spleen weight in male Wistar rats

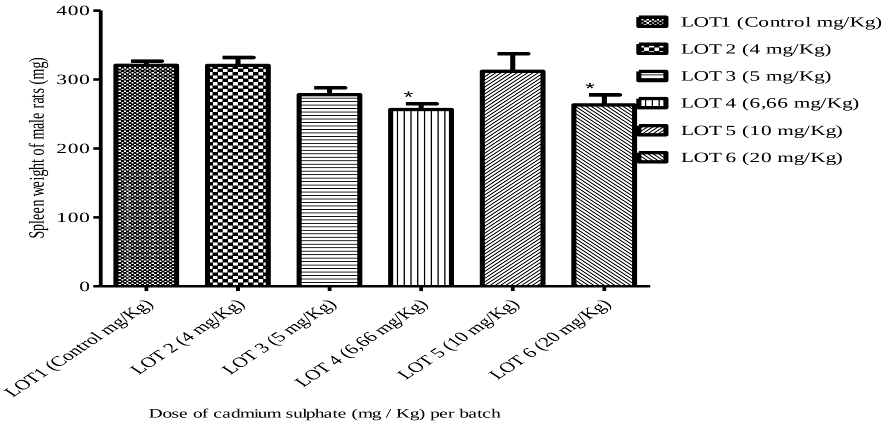

Figure 5: Effect of cadmium sulphate on spleen weight in male Wistar rats

Figure 5 shows the impact of cadmium on spleen weights in males. Cadmium resulted in a non-dependent dose decrease in the weight of this organ in treated lots. This decrease is significant ($p < 0.05$) for the dose of 6.66 mg / kg bw (256.33 ± 18.77 mg) and for the dose of 20 mg / kg bw (263.00 ± 32.53 mg) relative to the average weight of the control group (320.66 ± 13.43 mg) (Figure 5).

Effect of cadmium sulphate on mean spleen weight in female Wistar rats

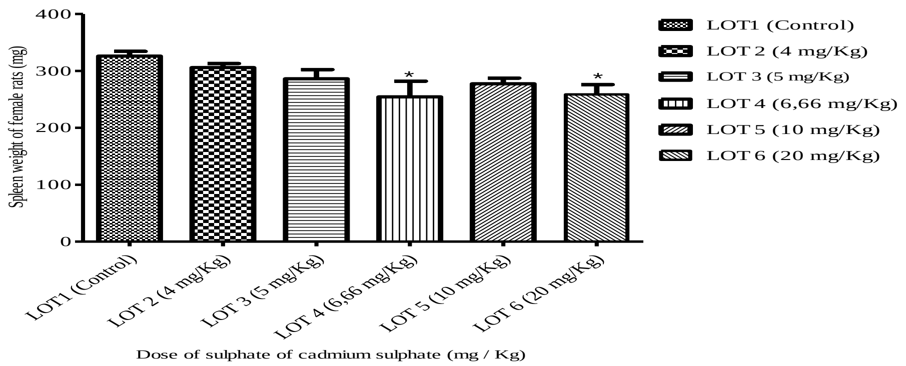

Figure 6: Effect of cadmium sulphate on spleen weight in female Wistar rats

Figure 6 shows the effect of cadmium on the weight of the spleen characterized by a decrease in the weight of this organ. Indeed, compared to controls, mean spleen weight of treated lots decreased in a non-dependent dose manner. Like males, the decrease in spleen weight was significant ($p < 0.05$) at doses of 6.66 mg / kg bw (254.40 ± 61.90 mg) and 20 mg / kg (258.8 ± 38.42 mg) pc in female rats compared to the control group (326.2 ± 18.43 mg) (Figure 6).

Effect of cadmium sulphate on mean heart weight in male Wistar rats

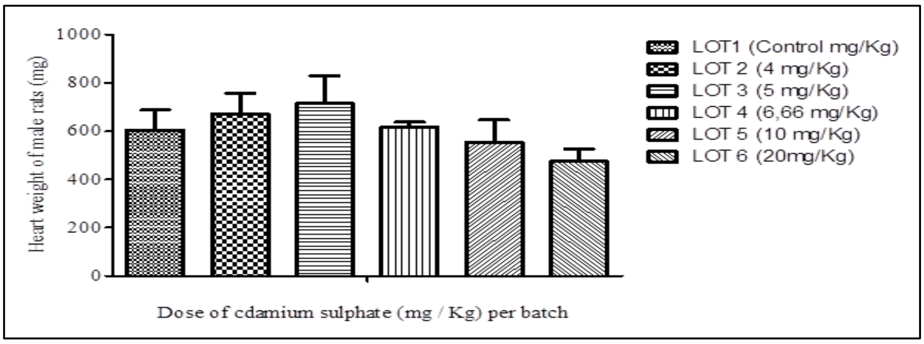

Figure 7: Effect of cadmium sulphate on heart weight in male Wistar rats

Figure 7 shows the impact of cadmium on heart weight in males. Cadmium resulted in a decrease or even a non-dependent increase in the weight of this organ in treated lots. The decrease is observed and significant at high doses ($p < 0.05$) for the dose of 10 mg / kg bw (553.75 ± 92.94 mg) and for the dose of 20 mg / kg bw (474.66 ± 51.86 mg) compared to average weight of the control group (604.8 ± 83.25 mg) (Figure 7). However, at low doses, cadmium sulphate resulted in increased heart weight ($p < 0.05$) at 4 mg / kg bw (669.5 ± 87.71 mg), 5 mg / kg bw (715.6 ± 114.9 mg). and 6.66 mg / kg bw (617.33 ± 20.10 mg) compared to the control group (604.8 ± 83.25 mg).

Effect of cadmium sulphate on mean heart weight in female Wistar rats

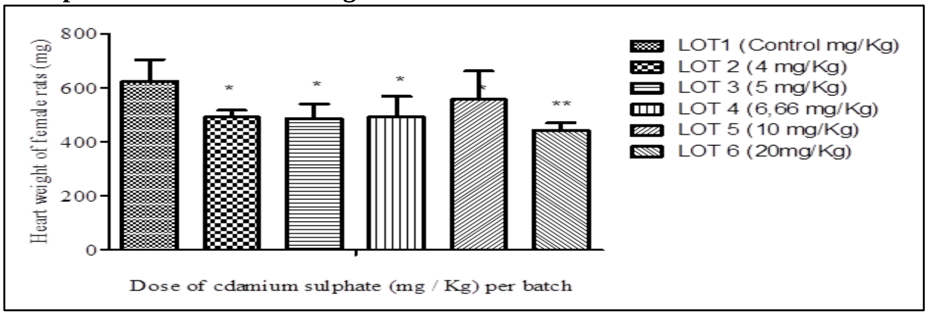

Figure 8: Effect of cadmium sulphate on heart weight in female Wistar rats

Figure 8 shows the effect of cadmium on the weight of the heart characterized by a decrease in the weight of this organ. Indeed, compared to the controls, the average heart weight of the treated lots decreased in a non-dependent dose. Like males, the decrease in heart weight was significant ($p < 0.05$) at doses of 4 mg / kg body weight (491.25 ± 25.25 mg), 5 mg / kg body weight (486.75 ± 53.13 mg), 6.66 mg / kg body weight (493. ± 75.40 mg), 10 mg / kg body weight (556.2 ± 106.07 mg) and 20 mg / kg body weight (442.8 ± 27.761 mg) in female rats compared to the control group (623.8 ± 80.50 mg) (Figure 8).

Cadmium sulphate does not act in the same way on both sexes at low doses on the heart.

Effect of cadmium sulphate on mean lung weight in male Wistar rats

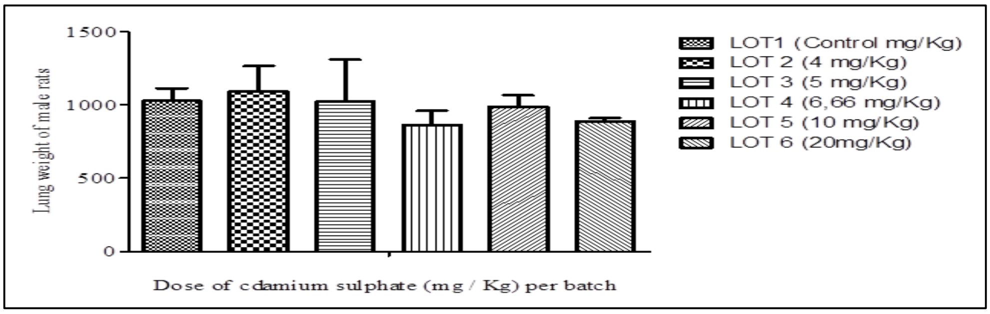

Figure 9: Effect of cadmium sulphate on lung weight in male Wistar rats

Figure 9 shows the impact of cadmium on lung weight in males. Cadmium resulted in a non-significant or even non-significant increase in non-dependent dose of this organ in treated lots. The non-significant decrease is observed at doses of 5 mg / kg body weight (1022.6 ± 286.46 mg), 6.66 mg / kg body weight (864.33 ± 95.35 mg), 10 mg / kg body weight (988.25 ± 76.22 mg) and 20 mg / kg pc (886.33 ± 24.44 mg) compared to the control group mg / kg bw (1027.2 ± 86.76 mg). Cadmium sulphate had no effect on the lungs in males.

Effect of cadmium sulphate on mean lung weight in female Wistar rats

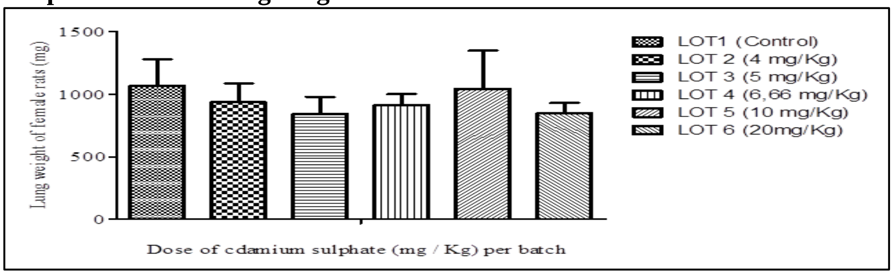

Figure 10: Effect of cadmium sulphate on lung weight in female Wistar rats

Figure 10 shows the effect of cadmium on the weight of the lungs characterized by a non-significant decrease in the weight of this organ. The decrease in lung weight was not significant ($p > 0.05$) at doses of 4 mg / kg. Kg pc (935.75 ± 151.81 mg), 5 mg / kg body weight (843.5 ± 135.63 mg), 6.66 mg / kg body weight (912.4 ± 89.07 mg), 10 mg / kg body weight (1043.6 ± 304.40 mg) and 20 mg / Kg pc (849.2 ± 81.31 mg) in female rats compared to the control group (1065 ± 215.98 mg) (Figure 10).

As in males, cadmium sulphate had no effect on the lungs in females.

DISCUSSION

The liver, kidneys and spleen are important organs in the metabolism, detoxification, storage and excretion of chemicals and their metabolites (AL-Gehan., 2013).

The work done by Jelena *et al.*, 2014 recorded a concentration of cadmium in the blood, spleen, kidneys and liver. This is the proof of the distribution of cadmium in the organs. According to Josthna et al. (2012), cadmium accumulates more in the liver than in tissues and kidneys. Long-term environmental exposure to Cd can be dangerous in humans (Achanza *et al.*, 2001). Heavy metal pollution is an important environmental problem. Their toxic effects and their accumulation throughout the food chain cause serious environmental and health problems (Kadukova and Vircikova, 2005). Thus, food may be considered as the most important source of cadmium exposure and penetration into the body (Mohammed and Karkaz, 2015).

The results obtained showed a significant decrease in organ weights (liver, kidney and spleen) compared with controls. The atrophy of vital organs could be explained by cellular atrophy and / or a decrease in cell multiplication due to the fact that cadmium affects cellular activity, proliferation and differentiation and consequently leads to apoptosis of the cells. cells (Onwuka, 2010) by activation of caspase 3 (Jacquillet *et al.*, 2006, Nasim *et al.*, 2014). The reduction in average weight of the liver and kidneys could also be explained by the loss of body weight according to AL-Gehani., 2013 during their work. This work thus carried out by AL-Gehani, (2013) where the rats treated with 50 mg / L of Cd are similar to the results obtained as to the toxic effect of cadmium on vital organs. In the same vein, according to the study by Josthna *et al.*, (2012), these toxic effects of cadmium sulphate would result in a decrease in the daily average of food and water in rats. According to several previous studies, cadmium damages vital organs such as the liver, kidneys and spleen (Haki *et al.*, 2005) that may explain this decrease in average organ weights. The results obtained are similar to those of BERROUKCHE *et al.*, (2014), where it has been found that the weight of the organs and their relative weights have decreased. Cadmium thus prevents growth and has toxic effects on the kidneys, liver, lung, testes, placenta and erythropoietic system (Randa., 2012). For example, in chickens, cadmium causes immune suppression, suppression of cellular and humoral immune responses, and atrophy of the spleen (Li *et al.*, 2010). The mechanism of splenic atrophy is unknown, but in inflammatory bowel disease splenic atrophy may also occur (Trewby *et al.*, 1981). However, when rats were exposed to cadmium in the present study, no hematuria was observed.

In the study by WANG *et al.*, (2014), a nonsignificant decrease compared to the control of organ weights (liver and kidneys) was observed in rats; this indicates that the effects of Cd in vivo or in vitro may be due to different dosages or duration of exposure (Jelena *et al.*, 2014).

CONCLUSION

Cadmium sulphate resulted in a decrease in the average weight of the internal organs (kidneys, spleen, liver and heart) in a non-dependent dose. However, it had no effect on the lungs in rats given the mode of administration (ingestion). This work can therefore be used as a health biomarker method for environmental exposure regarding the evaluation of chemicals.

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