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## The role of nutrition in maintaining the effectiveness of the liver (enzymes and some blood variables) against heavy metals efficacy of leek powder in maintaining liver functions against cadmium negative effects

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### Abstract

The issue of heavy metals pollution, particularly cadmium, holds paramount importance in today's context due to its severe negative impact on human health. In this study, the efficacy of leek plant leaf powder as a natural remedy to mitigate the adverse effects of cadmium on specific blood parameters and internal organs in experimental rats was investigated. The experimental groups consisted of a negative control (T<sub>1</sub>: 0.4 µg/L), a positive control (T<sub>2</sub>: 25.7 µg/L, cadmium-injected), and therapeutic interventions (T<sub>3</sub>: 5.3 µg/L, T<sub>4</sub>: 5.6 µg/L, cadmium-injected rats fed diets supplemented with 2% and 3% leek powder, respectively). Results demonstrated that cadmium (T<sub>2</sub>) significantly impacted blood cadmium levels (25.7 µg/L) compared to control (T<sub>1</sub>: 0.4 µg/L) and had adverse effects on internal organs (kidneys 5.4 grams, testes 5.1 grams, liver 19.1 grams, heart 0.8 grams, and spleen 2.2 grams) compared to control (T<sub>1</sub>: Kidneys 2.8 g, testicles 7.5 g, liver 10 g, heart 1.2 g, and spleen 0.7 g). Cadmium also led to elevated enzyme levels in the blood compared to control (T<sub>1</sub>) (AST 22.5 U/l, ALT 29.1 U/l, Alkaline Phosphatase 18.3 IU/L), with levels of AST 60.1 U/l, ALT 117.0 U/l, and Alkaline Phosphatase 49.0 IU/L in the positive control (T<sub>2</sub>). The therapeutic approach with leek (T<sub>3</sub>) demonstrated superior results in mitigating cadmium's detrimental effects, followed by T<sub>4</sub>, as evidenced by internal organ weights, blood cadmium levels, and liver enzymes. The study concludes that leek exhibits robust therapeutic potential in countering cadmium's effects, particularly at a 2% concentration. This research marks a pioneering effort in exploring leek's therapeutic role in addressing cadmium toxicity.

**Keywords:** Cadmium, leek, liver, kidneys, rat testicles

### Introduction

Heavy metals are a totally important in plenty of enterprise, agricultural, and medical programs. Despite the importance of heavy metals, they pose a completely critical threat and a huge challenge to the industries. This venture is because of the each day practices of the character and the amount to which they're practiced right now and indirectly with heavy metals in phrases of toxicity and the opportunity of metals transporting in the human body (Kang *et al.*, 2019; Yu *et al.*, 2020; Zou *et al.*, 2021) [6, 17, 20]. Cadmium is one of the maximum dangerous heavy metals, pretty poisonous and with an opportunity of gathering inside the human frame (Hayat *et al.*, 2018; Wang *et al.*, 2017; Zheng *et al.*, 2020; Zou *et al.*, 2021) [3, 16, 19, 20]. Human is uncovered to cadmium proper now, as is the case in smoking, refining strategies, dyes enterprise, plastic industries, inhalation of gases, teeth and ceramic industries (Hayat *et al.*, 2018; Wang *et al.*, 2017; Zheng *et al.*, 2020; Zou *et al.*, 2021) [3, 16, 20]. Or indirectly, wherein human beings are consuming affected end result, veggies, fish, and seafood (Wang *et al.*, 2017; Zheng *et al.*, 2020) [16, 19].

Cadmium has been categorized as a detail not important for plenty living organisms. Moreover, it's miles an international environmental pollutant that isn't always environmentally degradable (Hirao-Suzuki *et al.*, 2021; Karami *et al.*, 2022; Sun *et al.*, 2021; Wang *et al.*, 2017) [4, 7, 13, 16]. Cadmium threat will boom all through lady's pregnancy due to its capacity to move from the placenta to the fetus (Ibiwoye *et al.*, 2019) [5]. Moreover, for the duration of pregnancy cadmium can transfer to the blood, then to the mammary glands and breast milk causing mind and blood vessels harm in babies (Ibiwoye *et al.*, 2019; Liu *et al.*, 2020; Sola *et al.*, 2022) [5, 9, 12].

Cadmium influences the overall fitness of human beings, specially the inner organs (liver, kidneys, digestive system) and different essential organs (Hirao-Suzuki *et al.*, 2021; Yuan *et al.*, 2021; Zheng *et al.*, 2020) [4, 18, 19]. Chronic publicity to cadmium produces toxic outcomes and threatening adjustments on the histological stage of wounds and tissues of diverse cells (Wang *et al.*, 2017) [16]. It moreover can be volatile to bone tissue, the skeleton, and stem cells (Wang *et al.*, 2017; Zheng *et al.*, 2020) [16, 19]. Preliminary studies indicated the risk of cadmium to reprogrammed cells and seminiferous tubules in particular, and to the testes in stylish (Hirao-Suzuki *et al.*, 2021; Liu *et al.*, 2020; Wang *et al.*, 2017) [4, 9, 16]. One of those consequences at the organism nuclear tool is the interfering with every DNA and RNA translation and sports activities (Dong *et al.*, 2021; Hirao-Suzuki *et al.*, 2021; Suzuki *et al.*, 2017; Yuan *et al.*, 2021) [2, 4, 14, 18]. Therefore, cadmium can be classified as an exceptionally toxic and dangerous detail, and carcinogenic. Leek is a vegetable typically used all around the international. It has many beneficial natural homes due to its excessive content fabric of biologically active compounds (Venditti *et al.*, 2021) [15]. Leek possesses antibacterial interest due to its content fabric material of sulfur compounds (Venditti *et al.*, 2021) [15]. The antioxidant efficacy of the plant is commonly because of its excessive content material of phenolic compounds which includes quercetin isorhamnetin four -O-glucoside three, four -O-Di glucoside, quercetin four -O-glucoside, quercetin 3-O-glucoside and quercetin aglycone (Bernaert *et al.*, 2013) [1]. Therefore, the study aimed to assess the opportunity of the usage of leek powder in one of a kind proportions inside the eating regimen of rats to reduce the toxic and pathogenic consequences in rats uncovered to cadmium.

## Materials and Methods

### Preparation of medicinal plants

Leek leaves (*Allium porrum* L.) were collected from local grocery markets in Najaf, Iraq. The fresh fine leek leaves were selected, sorted, washed with D.W three times (Pierart *et al.*, 2018) [11]. Then, the leaves were spread as a thin layer on perforated aluminum foil (5.50 m x 7.50 m) on the laboratory benches and left for 8 h to air dry at 28±2 °C. The dry leek material was processed by crushing and grinding to be mix with the regular feed (Razi Vaccine and Serum Research Institute, Karaj, Iran).

### Cadmium source

Cadmium has been used as (CdCl<sub>2</sub>) Gew.379.34 E. Merck, Darmstadt, Germany (Hirao-Suzuki *et al.*, 2021; Sola *et al.*, 2022; Wang *et al.*, 2017; Yuan *et al.*, 2021; Zheng *et al.*, 2020) [4, 12, 16, 18, 19]. Groups T (2,3,4) have been Intraperitoneal Injected ((LD, Lethal dose) 0.4 mg /kg body weight, 5 times per week) (Hirao-Suzuki *et al.*, 2021; Sola *et al.*, 2022; Wang *et al.*, 2017; Yuan *et al.*, 2021; Zheng *et al.*, 2020) [4, 12, 16, 18, 19].

### Experimental design and data analysis

Twenty-eight wholesome male Sprague-Dawley rats weighing round 150-a hundred and eighty grams were used (Razi Vaccine and Serum Research Institute, Karaj, Iran). The rats have been divided into 4 agencies of 7 and kept in individual polypropylene cages that measured 380 mm by means of two hundred mm with the aid of 590 mm (Sun *et al.*, 2021; Ibiwoye *et al.*, 2019) [13, 5]. For a week, rats have been housed in the lab to permit them to acclimate to their new

surroundings (Wang *et al.*, 2017) [16]. According to Wang *et al.* (2017) [16], all rats were stored in managed laboratory conditions with a temperature of twenty-two±2 °C, a humidity level of 30-35%, and a 12-hour mild/dark cycle. The trial ran for eight weeks. Water became available to all treated laboratory groups on an as-wished basis. (Wang and co-workers, 2017; Ibiwoye *et al.*, 2019) [16, 5]. Four organizations (Treatments) had been randomly assigned to the rats. Regular widespread diet was used for the treatments T<sub>1</sub> (manage) and T<sub>2</sub> which have been injected with cadmium (high-quality control), even as cadmium injected rats of treatments T<sub>3</sub> and T<sub>4</sub> have been consumed weight loss program supplied with 20% leek leaf powder (20g leek leaf powder/980 g normal feed powdered), and 30% (30 g /970 g), respectively. The feed changed into poured and formed in molds as 0.6 liters of water was brought to every 1 kg feed and pressed into molds and furnished to the rats. The daily measurements of the distinct companies of rats have been taken periodically, and the variations are noted in terms of weight and the quantity of intake of feed and water.

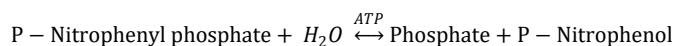
## Experimental measurements

### Blood tests

Each rat was given five milliliters of blood after being put to sleep (Lee *et al.*, 2017) [8]. The samples were separated using EDTA tubes with serum Sep clot activator. Kavush Laboratory and the National Iranian Standardization Organization tested the blood.

### Alkaline Phosphate Determination

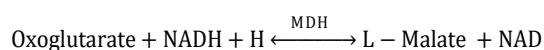
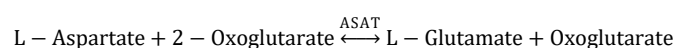
The liver enzyme ALT (alanine aminotransferase) was tested using the Commercial ALAT (GPT) Test base (DGKC) Method.



(Mohamed Basuony, Ezar Hafez, Ehab Tousson, Ahmed Massoud, Samar Elsomkhraty and Zoology, 2018) [10].

### The AST Determination

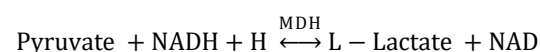
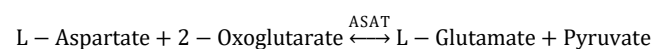
Aspartate aminotransferase (AST) was determined using the commercial method ASAT (cot) by the IFCC in order to quantify liver enzyme.



(Mohamed Basuony, Ezar Hafez, Ehab Tousson, Ahmed Massoud, Samar Elsomkhraty and Zoology, 2018) [10].

### Alanine Aminotransferase (ALT) Assessment

The ALT (alanine aminotransferase) was tested using the commercial technique ALAT (GPT) by the IFCC to determine the liver enzyme.



### Internal organs: Kidneys, heart, testes, and liver

Following the experiment, the rats were put under anesthesia and put to death by euthanasia, and the weights of their internal organs were then calculated.

### Statistical analysis

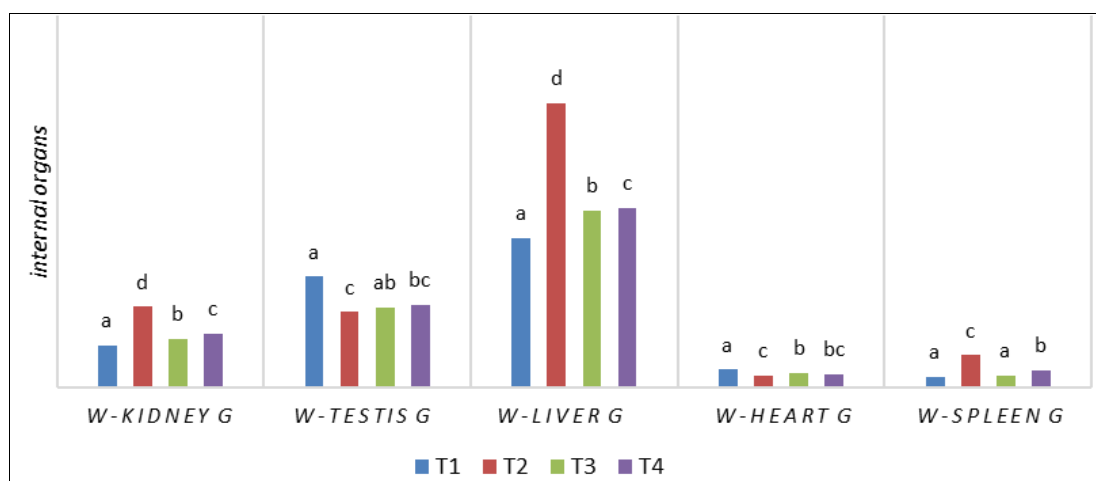
In this study, the interaction between the different dosages of leek leaf powder was investigated by topical tests utilizing a complete random design (CRD). Least significant difference (LSD) and general statistics (2012) were employed in the statistical analysis of the data reviewed to analyze statistically significant differences between the treatment averages.

### Results

#### Internal organs

The results showed that the injection of rats with cadmium (T<sub>2</sub>) in the untreated positive control resulted in destructive effects on the internal organs, which led to abnormal weight of kidneys (5.4 g), testes (5.1 g), liver (19.1 g), heart (0.8 g), and spleen (2.2 g) compared to the normal organs' weight measurements in the control treatment (Kidneys 2.8 gm, testicles 7.5 gm, liver 10 gm, heart 1.2 gm, and spleen 0.7 gm). Through the results, it was found that rats of the T<sub>3</sub> and T<sub>4</sub> treatments (therapeutic feeding on a diet with 20% and 30% leek powder, respectively) reduced the cadmium

negative effects. T<sub>3</sub> and T<sub>4</sub> resulted in internal organ weights for kidneys 3.2 and 3.6 g, testes 5.4 and 5.5g, liver 11.9 and 12.1 g, heart 1 and 0.9 g, and spleen 0.8 and 1.2g, respectively (Table 1). Table 1. Effect of injection with cadmium and feeding on a diet supplemented with leek (*Allium porrum* L.) powder on rat's Internal organs: Heart, Liver, Spleen, Testicles, and Kidney \*Values are means of 3 replications. Treatments are control (T<sub>1</sub>), positive control T<sub>2</sub> (animal injected with cadmium), and T<sub>3</sub> and T<sub>4</sub> for cadmium-injected animals fed on a diet supplemented with 2% and 3% leek powder, respectively. According to Duncan's multiple ranges test, there is a significant difference ( $p \leq 0.05$ ) between the means within a column that are followed by a different letter or letters. In response to the findings of cadmium poisoning, the weight of the kidneys, liver, and spleen all rose, suggesting an internal organ poisoning and inflammatory state (Figure 1). The effect of cadmium on both the weight of the heart and testicles leads to a decrease in their weight, and this is evidence of a decrease in their efficiency and atrophy of these organs.



**Fig 1:** Shown evidence of a state of inflammation and poisoning at the level of the internal organs of the body

**Table 1:** Effect of injection with cadmium and feeding on diet supplemented with leek (*Allium porrum* L.) powder on rat's internal organs: Heart, Liver, Spleen, Testicles, and Kidney

Treatments (T)	Parameters					
	Kidney weight	Testis Weight	Liver Weight	Heart weight	Spleen weight	
T <sub>1</sub>	2.8a±0	7.5a±0	10.0a±0	1.2a±0	0.7a±0	
T <sub>2</sub>	5.4d±0	5.1c±0	19.1d±0	0.8c±0	2.2c±0	
T <sub>3</sub>	3.2b±0	5.4ab±0	11.9b±0	1.0b±0	0.8a±0	
T <sub>4</sub>	3.6c±0	5.5bc±0	12.1c±0	0.9bc±0	1.2b±0	
P-Value	Treatment	<.0001	<.0001	<.0001	<.0001	<.0001
	Time (Ti.)	<.0001	<.0001	<.0001	<.0001	<.0001
	T*Ti.	<.0001	<.0001	<.0001	<.0001	<.0001

\*Values are means of 3 replications. Treatments are control (T<sub>1</sub>), positive control T<sub>2</sub> (animal injected with cadmium), and T<sub>3</sub> and T<sub>4</sub> for cadmium-injected animals fed on a diet supplemented with 2% and 3% leek powder, respectively. Means followed by the different letter(s) within a column are significantly different according to Duncan's multiple ranges test ( $p \leq 0.05$ )

Figure 1, Cadmium negative effect on the rat's internal organs weights. \*Values are means of 3 replications. Treatments are control (T<sub>1</sub>), positive control T<sub>2</sub> (animal injected with cadmium), and T<sub>3</sub> and T<sub>4</sub> for cadmium-injected animals fed on a diet supplemented with 2% and 3% leek powder, respectively. Bars that have different letter(s) are significantly different according to Duncan's multiple ranges test ( $p \leq 0.05$ ).

#### Blood cadmium levels and liver enzymes (AST, ALT, and Alkaline Phosphatase)

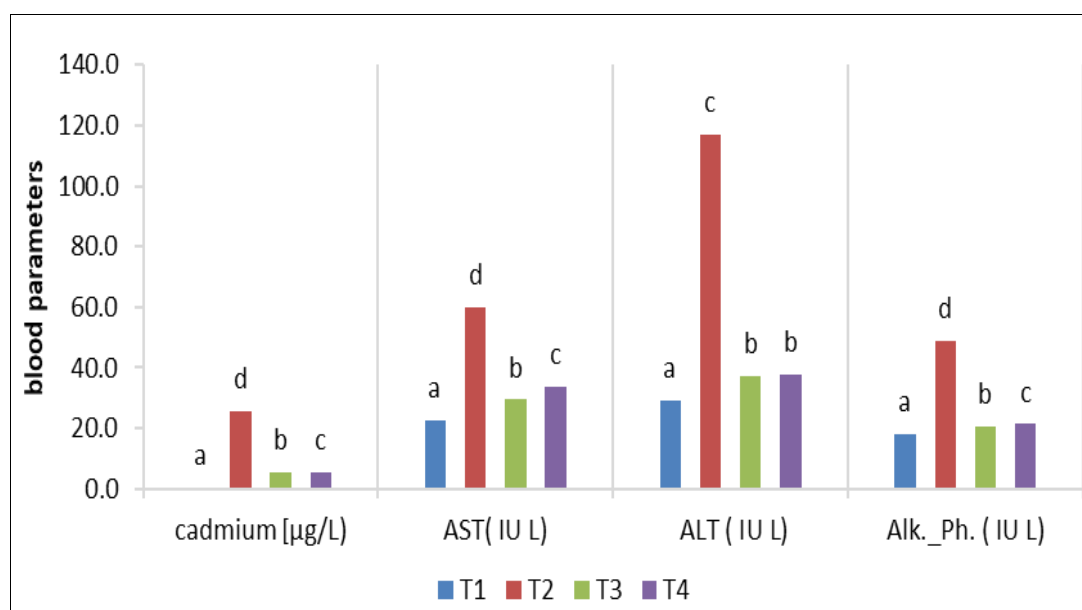
It was observed that the highest levels of cadmium in rat's blood (25.7 µg/L) were recorded in T<sub>2</sub> (positive untreated

control), while the control T<sub>1</sub> recorded 0.4 µg/L which was the lowest among the treatments. On the other hand, leek leaf powder was effective in decreasing cadmium levels in rat's blood compared to T<sub>2</sub>. The therapeutic treatments T<sub>3</sub> and T<sub>4</sub> resulted in cadmium levels of 5.3 µg/L and 5.6 µg/L, respectively. The liver enzymes (AST, ALT, Alkaline Phosphatase) were highly affected by cadmium (Figure 2). Cadmium in the T<sub>2</sub> treatment led to a significant increase in the levels of these enzymes compared to the T<sub>1</sub> control and the groups fed on leek powder T<sub>3</sub> and T<sub>4</sub> treatments. The latter two treatments significantly lowered the enzyme levels (Table 2) under study.

**Table 2:** Cadmium negative effect on the rat's blood parameters: Cadmium [ $\mu\text{g/L}$ ], Alkaline Phosphatase, Alanine Transaminase and Aspartate Transaminase level

Treatments (T)	Parameters			
	Cadmium [ $\mu\text{g/L}$ ]	AST (U/l)	ALT (U/l)	ALP (IU/L)
T <sub>1</sub>	0.4a $\pm$ 0	22.5a $\pm$ 0	29.1a $\pm$ 0	18.3a $\pm$ 0
T <sub>2</sub>	25.7d $\pm$ 0	60.1d $\pm$ 0	117.0c $\pm$ 0	49.0d $\pm$ 0
T <sub>3</sub>	5.3b $\pm$ 0	29.4b $\pm$ 0	37.2b $\pm$ 0	20.6b $\pm$ 0
T <sub>4</sub>	5.6c $\pm$ 0	33.7c $\pm$ 0	37.9b $\pm$ 0	21.3c $\pm$ 0
P-Value	T	<.0001	<.0001	<.0001
	Time	<.0001	<.0001	<.0001
	T*T <sub>1</sub>	<.0001	<.0001	<.0001

\*Values are means of 3 replications. Treatments are control (T<sub>1</sub>), positive control T<sub>2</sub> (animal injected with cadmium), and T<sub>3</sub> and T<sub>4</sub> for cadmium-injected animals fed on a diet supplemented with 2% and 3% leek powder, respectively. Duncan's multiple ranges test indicates that the means in a column that are followed by a different letter or letters are statistically different ( $p \leq 0.05$ )



**Fig 2:** Cadmium negative effect on the rat's blood parameters: cadmium [ $\mu\text{g/L}$ ], Alkaline Phosphatase (Alk. Ph), Alanine Transaminase (ALT) and Aspartate Transaminase (AST) level. Values are means of 3 replications. The animal injected with cadmium (positive control T<sub>2</sub>), control (T<sub>1</sub>), and cadmium-injected animals provided a meal supplemented with 2% and 3% leek powder, respectively, are the treatments. Duncan's multiple ranges test indicates that bars with distinct letter(s) are significantly different ( $p \leq 0.05$ )

## Discussion

In the discussion section, you would elaborate on the significance of these results, compare them with existing literature, provide possible explanations for the observed effects, and draw broader conclusions about the implications of your findings. This is the space to interpret your results in the context of the research question and share insights that contribute to the scientific understanding of the topic. Regarding the effect of cadmium on the internal body organs, these results were in agreement with previous studies about such effects by cadmium (Ibiwoye *et al.*, 2019; Wang *et al.*, 2017) [5, 16]. In the discussion section, you would elaborate on the significance of these results, compare them with existing literature, provide possible explanations for the observed effects, and draw broader conclusions about the implications of your findings. This is the space to interpret your results in the context of the research question and share insights that contribute to the scientific understanding of the topic. You can also discuss the implications of the findings for both the specific field and potential practical applications (Venditti *et al.*, 2021) [15].

## Conclusion

The investigation showed the negative effects of cadmium on the weights of internal organs and various liver enzymes, in addition to the levels of cadmium in the blood. The study

found that Leek powder has an effective role in reducing the effects caused by cadmium, the treatment T<sub>4</sub> showed very good results, while the best results were the result of T<sub>3</sub> in reducing those toxic effects of cadmium. These results showed the Leek important role for health by reducing the negative effects heavy metals (cadmium).

## Authors' contributions

The authors collaborated with each other to complete the study. Mortada designed the study and supervised its implementation. Mortada and Ali performed the laboratory analyses, as well as preparing the manuscript first draft. Zinah and Hasan analyzed the data and reviewed the literature for this study. All authors have read the study (final version) and confirmed it for publication.

## Conflict interest

Neither the authors nor the researchers involved in this study have any financial or personal interests that could potentially lead to conflicts of interest. The research was conducted with a focus solely on contributing to the scientific knowledge and understanding within the field.

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