

# Dietary Importance of *Physalis Peruviana* and its Efficacy Against Lead Toxicity in Rats

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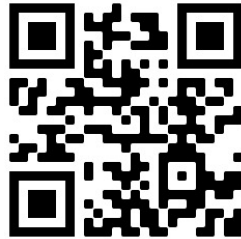
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## Dietary Importance of *Physalis Peruviana* and its Efficacy Against Lead Toxicity in Rats

### Abstract

This study was carried out to investigate the dietary importance of *Physalis Peruviana* (PP) and its efficacy against lead toxicity in rats. Thirty young albino rats of Sprague-Dawley strain weighing approximately  $50 \pm 5$  gm were randomly distributed after the adaptation period into five main groups, the first group (6 rats) was kept on the basal diet as negative control (-ve), while rats in other groups were exposed to lead acetate and divided into four groups (6 of each). Group two was positive control (+ve) , while the other three groups were fed on a basal diet supplemented with dried PP at three levels 5% , 10%, and 15% for 6 weeks. Body weight gain was calculated. Calcium, phosphorus, alkaline phosphate (ALP), lead, liver enzymes such as Alanine Aminotransferase (ALT) and Aspartate Aminotransferase (AST), in addition, kidney functions such as urea nitrogen and creatinine were determined in serum also, antioxidants enzymes as well as MDA were analyzed, histopathological examination liver and kidneys were done. Results showed an increase in body weight gain in groups fed on diet containing PP compared with the positive control group. Liver enzymes such as alanine transaminase (ALT), aspartate aminotransferase (AST), in addition, urea nitrogen and creatinine were decreased significantly in groups 3, 4 and 5 respectively compared with the positive control group. PP caused significant improvement in calcium and phosphorus concentrations in serum compared with the positive control group. The lowest harmful effect from lead appears in a group of rats that fed on PP at three levels compared with the positive control group. Urea nitrogen and creatinine levels were significantly improved when rats were fed on three levels of PP powder. Also, results showed that ALP concentration was significantly decreased when rats were fed on PP powder. Antioxidant enzymes (SOD and CAT) were significantly increased in groups 3,4 and 5, respectively compared with the positive control group. However, MDA was decreased significantly in groups 3,4 and 5, respectively

compared with the positive control group. Thus, this study concluded that PP powder at three levels had a good effect on health by limiting the toxic effect induced by heavy metals especially lead.

**Key Words:** Lead toxicity, *Physalis Peruviana*, liver enzymes, Antioxidant enzyme, Urea Nitrogen, Rats.

## Introduction

The fruits of *Physalis peruviana* L. (PP) are also named golden berry, gooseberry, winter cherry fruits, and cape gooseberry all over the world (Hassanien, 2011). *Physalis* species are grown naturally and cultured in a lot of countries including North and South African countries, India, Australia, New Zealand, Colombia and Chile (Merikli, 2011).

The benefits associated with the consumption of PP are mainly due to their nutritional composition. PP contains biologically active components that provide health benefits and reduce the risk for most diseases. Among its major components are its high amounts of vitamins A, B, and C, polyunsaturated fatty acids,  $\beta$ -carotene, and phytosterols. *Physalis peruviana* L has essential minerals such as iron (Ramadan , and Möersel, 2007).

PP powder showed antioxidant activity (Chang et al., 2008), as well as antihepatotoxic effect (Arun, and Asha V, 2007) , and anti-inflammatory activity (Wu et al., 2006). In addition, it has excellent potential as a food-based strategy as anti-diabetes and anti-hypertension effect (Pinto et al., 2009).

The PP plant, known to have chemotherapeutic effects, is extensively used in folk medicine to treat malaria, asthma, hepatitis, dermatitis, diuresis, rheumatism (Wu et al., 2006), and visual acuity reduction with interesting polyphenols such as 28-hydroxywithanolide, withanolides, phygrine, kaempferol, and quercetin di- and triglycosides (Pardo et al., 2008).

The antioxidant and biological activities of PP have been reported in many researches. PP has been shown to inhibit the growth of

different cancer cell lines and exhibit protective effects in the liver and other cells. Some studies have observed apoptosis activated by mitochondrial signaling in macrophages, hepatocytes, monocytes, T lymphocytes, and natural killer cells, which demonstrates the enormous potential of this plant in food and herbal medicine applications (**Dkhal et al., 2014**). PP fruits extracts have functioned as tumor cell inhibitors as well as the impact of these natural extracts on epidermal cells and untapped potential.

Lead is among the more common toxic metals present in our environment it is one of the most important metals that pollute the natural environment due to man's impact (**Komousani and Moselhy, 2011**). Lead effect on the central nervous system, while exposure to the metal is associated with several psychological alterations and neurobehavioral (**Bressler and Goldstein, 1991**). The developmental toxicity of lead has become a significant area of research since children are much more sensitive than adults to the impairment following low-level lead exposure (**Davis and Svendsgaard, 1987**). So, animal and human studies have reached similar results, since behavioral effects induced by lead are seen in rats at approximately the same blood levels that cause deficits in humans (**Davis et al., 1990**). Therefore, this study was conducted to recognition the dietary importance of PP and its efficacy against lead toxicity in rats.

## Materials and methods

### Materials:

Cellulose, lead acetate, vitamin mixture and minerals were purchased from El-Gomhoria Company, Cairo- Egypt. PP were purchased from the local market. Thirty young albino rats of Sprague-Dawley strain weighing approximately  $50 \pm 5$  gm were purchased from Helwan Farm for Experimental Animals, Cairo, Egypt. Kits for biochemical analysis, Casein, vitamins, minerals, cellulose, starch, and choline were obtained were purchased from El-Gomhoria Company for Trading Drugs, Chemicals and Medical Requirements

## Methods:

### Preparation of *Physalis Peruviana* powder:

PP collected and dried with solar energy in National Research Center. Dried *Physalis peruviana* was grounded in the multi mill then obtained a fine powder then stored in a clean container until used.

### Experimental animal design:

#### Preparation of basal diet:

The basal diet was prepared according to *Reeves et al. (1993)*. It consists of 20 % protein, 10 % sucrose, 4.7% corn oil, 2% choline chloride, 3.5 % salt mixture, 1% vitamin mixture, and 5% fibers. The remainder was corn starch up to 100 %.

Animals were divided into five main groups (n=6, once). The first main group (n=6) was fed on the basal diet during the experimental period as a negative control group (-ve). The rest of the animals (n=24) were exposed to lead toxicity (using lead acetate) at a 200 mg /kg diet according to *Newairy and Abdou ,(2009 )* and assigned to 3 groups fed on different levels of *Physalis peruviana* powder in addition group fed on lead acetate diet which was used as a control positive group . All groups were assigned as follows:

**Group1:** Rats fed on the basal diet all over the experimental period as a negative control (-ve).

**Group2:** Rats fed on lead acetate diet as a positive control (+ve) .

**Group3:** Rats fed on a basal diet with 5% from powder *Physalis peruviana*.

**Group4:** Rats fed on a lead acetate diet with 10% from powder *Physalis peruviana*.

**Group5:** Rats fed on a lead acetate diet with 15% from powder *Physalis peruviana*.

At the end of the experiment (6weeks) body weight gain was calculated. All rats fasted overnight, lightly anesthetized under ether. Blood was withdrawn into clean dry centrifuge plastic tubes. Blood samples were centrifuged and serum was obtained then stored at -20° C in a clean well stopped vial until analysis.

### **Biochemical analysis: -**

The enzyme alanine aminotransferase (ALT) was determined in serum to the method of *Sherwin (1984)*. The enzyme aspartate aminotransferase (AST) was determined according to *Young (1990)*. Serum alkaline phosphatase (ALP) was determined according to the method described by *Roy (1970)*. Serum urea nitrogen concentration was determined by the method of *Fossati et al., (1980)*. Creatinine was determined according to the method described by *Henry (1974)*. Serum lead concentration was determined by the method of *Parsons, (2001)*. Serum malondialdehyde (MDA) was determined according to *Draper and Hadly (1990)*. Serum CAT activity was measured in tissue homogenate according to *Aebi (1984)*. Serum SOD activity was measured according to *Nishikimi et al., (1972)*.

### **Statistical analysis:**

Autopsy samples were taken from the liver and kidney of rats in different groups and fixed in 10% formalin solution. The results were expressed as mean  $\pm$  standard error (SE). The statistical analysis was carried out by using SPSS, PC statistical software (Verion 18.0 SPSS Inc., Chieago, USA) using the Dunk 'test multiple range post-hoc test. Data were analyzed by one way analysis variance (ANOVA). The values were considered significantly different at  $P < 0.05$  (*Snedecor and Cochran, 1980*).

## **Results and Discussion**

### **Flavonoids and polyphenolic contents of PP**

Table 1 shows the content of total (flavonoids and polyphenolics) in PP. Flavonoids content in PP was 89.4  $\mu\text{g}/\text{mg}$  quercetin equivalents of flavonoids / mL juice. The total polyphenolic content was 121.3  $\mu\text{g}/\text{mg}$  gallic acid equivalent of polyphenols/mL juice. This results showed no significant changes were observed between the initial and final flavonoids and phenolics contents (*Ebtisam et al., 2014*).

**Table (1):** Total flavonoids and polyphenolic contents of PP in different conditions

Data are represented as mean  $\pm$  SEM of two independent experiments each performed in duplicate, \* Stored at room temperature for 3 days

Conditions	Total phenolics	Total flavonoid
Physalis juice, fresh	121.3 $\pm$ 4.65	89.4 $\pm$ 4.82
Physalis juice, store*	113.5 $\pm$ 5.31	81.7 $\pm$ 3.74

### The effect of PP at different levels on body weight gain of lead intoxicated rats:

Results in Table 2 showed that body weight gain (BWG) was significantly lowered for the positive control group compared with the negative control one. In addition, BWG for rats in groups 3, 4, and 5 showed a significant increase in BWG when compared with the positive control rats. The increase in body weight gain with an increase in the levels of dried PP may be due to the effect of the odor, taste, and palatability of the rats to diet.

**Table (2):** The Effect of PP at different levels on body weight gain of lead intoxicated rats

Values are expressed as means  $\pm$  SE. Values at the same column with different letters are significantly different at  $P < 0.05$ .

Parameters Groups	BWG (g/dl)
G 1 (- Ve control)	21.33 $\pm$ 3.48 <sup>a</sup>
G 2 (+Ve control)	6.33 $\pm$ 2.40 <sup>d</sup>
G 3 ( 5% PP powder)	16.33 $\pm$ 2.84 <sup>b</sup>
G 4 ( 10% PP powder)	16.00 $\pm$ 0.57 <sup>b</sup>
G 5 ( 15% PP powder)	21.33 $\pm$ 1.20 <sup>a</sup>



## The effect of PP at different levels on serum concentrations of ALT, AST, and ALP of lead intoxicated rats.

Results in Table (3) showed the effect PP powder on serum activity of Alanine Aminotransferase (ALT). Data indicated that ALT activity was significantly increased when animals were exposed to lead toxicity (positive control group) with a mean value of  $20.00 \pm 1.15$  u/I compared with the negative control group ( $13.33 \pm 0.88$  u/I). However, when rats were fed on *Physalis peruviana* powder in the diet at three levels of intake were showed a decrease in the serum level activities of ALT when compared with the positive control group with the mean value of  $18.33 \pm 1.85$  u/l,  $19.66 \pm 1.85$  u/l and  $17.00 \pm 1.15$  u/l, respectively. The lowest activity of ALT in serum was showed in rats were fed on PP powder in the group (5) with a mean value  $17.00 \pm 1.15$  u/l.

The effect of PP powder on the activity of Aspartate Aminotransferase (AST) Presented in the same table. The group of rats that were exposed to lead toxicity (positive control group), had a significantly increased level of AST in serum with a mean value of  $35.00 \pm 1.15$  U/L compared with the negative control group  $31.00 \pm 1.52$  U/L. Results revealed that rats were fed on *Physalis peruviana* powder in the diet showed a reduction in the serum activity of AST at any levels of intake when compared with the positive control group . The lowest activity of AST in serum was showed in rats were fed on PP powder in the group (4) with a mean value  $27.66 \pm 3.17$  U/L .

In addition Table (3) showed the effect of PP powder on Alkaline Phosphatase (ALP). The activity of ALP in serum was increased significantly when rats were exposed to lead toxicity with a mean value of  $182.33 \pm 9.93$  u/L compared with the negative control group ( $107.33 \pm 10.71$  u/L). Results indicated that the mean value of ALP in serum was significantly decreased in the group of rats fed on *Physalis peruviana* powder at three levels in the diet as mean value  $134.66 \pm 1.85$  U/L,  $126.66 \pm 3.52$  U/L and  $117.66 \pm 3.92$  U/L, respectively when compared with positive control ( $182.33 \pm 9.93$  U/L).

Liver enzymes ALT and AST are important indicators of liver damage in clinic findings. These enzymes were secreted into the blood in hepatocellular injury and their level activities increase. Heights in these enzyme level activities might differ dependent on exposure time and dose. **Rao, (2006)** demonstrated that liver enzyme activities including AST and ALT are released into the plasma. In this sense, if the cellular injury is chronic AST and ALT levels will remain elevated. Our results were agreed with the results of **Khan et al., (2008)** they reported that, the activities of serum ALT and AST were significantly increased in lead-exposed rats. Also, the pathogenesis of lead toxicity is multifactorial as it directly interrupts enzyme activation, binds to sulfhydryl protein and lowers the level of available sulfhydryl antioxidant reserve in the body (**Heskel, 2003**). **Al-Wabel et al.,(2007)** recorded that activities of ALT and AST in addition to ALP were significantly increased in rats given daily lead acetate in the diet as 500mg /kg after 2,4 and 6 weeks of treatment. The fact that lead toxicity binds to enzymes that have functional sulfhydryl groups, rendering them non-functional and further contributing to impairment in oxidative balance, has been severally documented (**Ahamed et al., 2006**). In addition, **Ahmed and Mahdi (2014)** showed significant increase in AST and ALT activities in serum of related to exposed of toxicity comparison with the other groups.

Our results agreed with **Chang et al., (2008)** whose recommended that treatment with *Physalis peruviana* significantly reduced the levels of ALT and AST enzymes which were major indicators of liver hepatitis. This observation can be supported by the significant decrease in the levels of ALT, AST, and ALP. Besides decreasing the level of lipid peroxides in the liver, treatment of *Physalis peruviana* also led to an increase in CAT, SOD, and GPx levels in this organ. However **Basak et al., (2013)** recorded that the levels of hepatic biomarkers such as ALT and AST were not different in the animals who fed on a diet supplemented with *Physalis peruviana* compared to the controls, suggesting that *Physalis peruviana* does not induce hepatotoxicity. **Pun (2005)** found that the same *Physalis peruviana* plant material contains nineteen compounds it is possible

that some of these compounds might contribute to the antioxidant and hepatoprotective activities of PP.

In the same line with **Ebtisam et al., (2014)** recorded that PP intake in rats diets decreased significantly serum AST, ALT and ALP. These enzymes have been identified in cytotoxic and cholestatic hepatic injuries. The reason for these alterations by physalis is a clear indication of the improvement of the functional status of hepatocytes.

**Table (3): The Effect of PP at different levels on serum concentrations of ALT, AST, and ALP of lead intoxicated rats.**

Mean values in the same column sharing the same superscript letterers are not statistically significant,  $P \leq 0.05$ . Parameters (Mean  $\pm$ SE)

**ALT: Alanine Aminotransferase. AST: Aspartate Aminotransferase. ALP: Alkaline phosphatase**

<b>Parameters Groups</b>	<b>ALT (U/L)</b>	<b>AST (U/L)</b>	<b>ALP (U/L)</b>
<b>G 1 (- Ve control)</b>	13.33 $\pm$ 0.88 <sup>c</sup>	31.00 $\pm$ 1.52 <sup>b</sup>	107.33 $\pm$ 10.71 <sup>d</sup>
<b>G 2 (+Ve control)</b>	20.00 $\pm$ 1.15 <sup>a</sup>	35.00 $\pm$ 1.15 <sup>a</sup>	182.33 $\pm$ 9.93 <sup>a</sup>
<b>G 3 ( 5% PP powder)</b>	18.33 $\pm$ 1.85 <sup>ab</sup>	32.33 $\pm$ 1.76 <sup>b</sup>	134.66 $\pm$ 1.85 <sup>b</sup>
<b>G 4 ( 10% PP powder)</b>	19.66 $\pm$ 1.85 <sup>ab</sup>	27.66 $\pm$ 3.17 <sup>c</sup>	126.66 $\pm$ 3.52 <sup>bc</sup>
<b>G 5 ( 15% PP powder)</b>	17.00 $\pm$ 1.15 <sup>b</sup>	28.00 $\pm$ 4.04 <sup>bc</sup>	117.66 $\pm$ 3.92 <sup>c</sup>

## The effect of PP at different levels on serum concentrations of urea nitrogen and creatinine of lead intoxicated rats:

Table (4) showed the effect of PP powder on kidney functions (urea nitrogen and creatinine concentration in serum). When rats were exposed to lead toxicity the concentration of serum levels of urea nitrogen were significantly increased with a mean value of  $48.66 \pm 0.63$  mg/dl compared with the negative control group ( $40.10 \pm 0.89$  mg /dl). While the groups of rats fed on *Physalis peruviana* powder at any level of intake showed a significant decrease in serum levels of urea nitrogen to become as the normal levels compared with the positive control group. The concentration of serum level of urea nitrogen was  $38.06 \pm 0.92$  mg/dl,  $38.26 \pm 0.98$  mg /dl and  $35.30 \pm 1.50$  for groups 3,4 and 5, respectively when compared to the positive control group ( $48.66 \pm 0.63$  mg/dl).

The data in the same table showed that the positive control group which was exposed to lead toxicity had increased in the concentration of creatinine level with a mean value of  $1.05 \pm 0.07$  mg /dl compared with the negative control group ( $0.85 \pm 0.05$  mg / dl). Groups of rats were fed on PP powder at any levels of intake showed a reduction in the concentration of serum levels of creatinine compared with the positive control group. The best level was shown in group 4 as a mean value  $0.74 \pm 0.05$  mg / dl and consider better than the negative control group.

Serum creatinine, urea nitrogen levels are used in the assessment of renal toxicity. Creatinine, and urea nitrogen levels were measured to assess the renal toxicity. The increase in creatinine in the positive control group recorded in this work might be due to impaired kidney function by the used toxicity. This view was supported by **Ahmed et al., (2006)** who showed that an elevation of creatinine level in the blood is an indicator of impaired kidney function. In addition, **El-Shenawy et al., (2009)**, they reported that exposing mice to toxicity caused degeneration of renal tubules, atrophy of glomeruli and interstitial inflammatory cells infiltrations. Our results

are agreed with **Nabil *et al.*, (2013)** they reported that, there was a significant increase in serum urea nitrogen and creatinine in the lead-exposed group. The presence of the increased creatinine concentration in the blood suggests the inability of the kidney to excrete this product (**Overu *et al.*, 2004**). The elevation creatinine in serum caused by lead suggest that renal function impairment which might result from intrinsic renal lesions, decreased perfusion of the kidney obstruction of the lower urinary tract or due to deranged metabolic process caused by this metal (**Cameron and Greger, 1998**). The present results have been supported by **Abd El Rahiem *et al.* (2007)** who mentioned that lead acetate increased serum creatinine level compared to the control group. However, **Basak *et al.*, 2013** recorded that there are no significant differences in animals treated with PP compared to the controls.

**Abd El-Rahman *et al.*, (2016)** demonstrated that after treatment with Physalis extracts give additional support that Physalis mops up free radicals generation by CCl<sub>4</sub>, reduce inflammation, improve kidney function and induce a healthy state of renal cells. This observation suggested the Physalis role as a renal protective agent. Physalis *peruviana* is used as a new safe therapy that may enhance the anti-fibrotic mechanism, delay disease progression or reduce its complications. Complementary of Physalis *peruviana* ingredients with other constituents such as flavonoids and carotenoids should be considered/

**Table (4): The effect of PP at different levels on serum concentrations of urea nitrogen and ceatinine of lead intoxicated rats**

Mean values in the same column sharing the same superscript letterers are not statistically significant,  $P \leq 0.05$ . Parameters (Mean  $\pm$ SE).

Parameters Groups	Urea Nitrogen (mg/dl)	Creatinine (mg/dl)
G 1 (- Ve control)	40.10 $\pm$ 0.89 <sup>b</sup>	0.85 $\pm$ 0.05 <sup>b</sup>
G 2 (+Ve control)	48.66 $\pm$ 0.63 <sup>a</sup>	1.05 $\pm$ 0.07 <sup>a</sup>
G 3 ( 5% PP powder)	38.06 $\pm$ 0.92 <sup>b</sup>	0.80 $\pm$ 0.05 <sup>b</sup>
G 4 ( 10% PP powder)	38.26 $\pm$ 0.98 <sup>b</sup>	0.74 $\pm$ 0.05 <sup>c</sup>
G 5 ( 15% PP powder)	35.30 $\pm$ 1.50 <sup>c</sup>	0.81 $\pm$ 0.020 <sup>b</sup>

Results in Table (5) showed the effect of PP powder on serum levels of phosphorus and calcium. The serum concentration of phosphorus was decreased significantly when rats were exposed to lead toxicity with a mean value of 4.29 $\pm$ 0.13mg/dl compared with the negative control group (6.69 $\pm$ 0.06mg/dl). While, the concentrations of phosphorus in serum were increased significantly when rats were fed on PP powder at three levels of intake with mean value 4.77 $\pm$  0.12 mg/dl, 4.31 $\pm$ 0.89 mg/dl and 4.77 $\pm$ 0.05 mg/dl, respectively when compared with the positive control group (4.29 $\pm$ 0.13 mg/dl).

Data in this table (5) also showed that the serum concentration of calcium was increased significantly when rats were exposed to lead toxicity with a mean value of 6.29 $\pm$ 0.42mg/dl compared with the negative control group (4.30 $\pm$ 0.37mg/dl). While, the concentrations of calcium in serum were increased significantly when rats were fed on PP powder at three levels of intake with mean value 7.59 $\pm$ 0.43 mg/dl, 7.57 $\pm$ 0.89 mg/dl and 7.66 $\pm$ 0.67mg/dl, respectively when compared with the positive control group (6.29 $\pm$ 0.42mg/dl).

Calcium is important for the normal growth and development of the skeleton. Adequate calcium intake is critical for achieving optimal strong bone mass and modifies the rate of bone loss associated with aging (Cashman, 2002). In our study, serum levels of phosphorus and calcium for lead intoxicated groups showed an increase compared with the negative control group, which is similar to that recorded by (Heskel, 2003). The pathogenesis of lead (Pb) toxicity is multifactorial as it directly interrupts enzyme activation, completely inhibits trace minerals absorption, alters calcium homeostasis (Heskel, 2003). However, Missoun *et al.*, (2010) showed that phosphorus and calcium increase in serum of rats administered with lead acetate for 8 weeks. This may be due to impairment of renal function. In addition, lead has a direct effect on osteoblast function including, inhibition of active vitamin D3 stimulated synthesis of osteocalcin, a major non collagen constituent of bone important mineralization (Ronis *et al.*, 2001).

**Table (5): The effect of PP at different levels on serum phosphorus and calcium concentrations of lead intoxicated rats**

Mean values in the same column sharing the same superscript letterers are not statistically significant,  $P \leq 0.05$ . Parameters (Mean  $\pm$ SE)

Parameters Groups	Phosphorus (mg/dl)	Calcium (mg/dl)
G 1 (- Ve control)	6.69 $\pm$ 0.06 <sup>a</sup>	4.30 $\pm$ 0.37 <sup>c</sup>
G 2 (+Ve control)	4.29 $\pm$ 0.13 <sup>b</sup>	6.29 $\pm$ 0.42 <sup>b</sup>
G 3 ( 5% PP powder)	4.77 $\pm$ 0.12 <sup>b</sup>	7.59 $\pm$ 0.43 <sup>a</sup>
G 4 ( 10% PP powder)	4.31 $\pm$ 0.89 <sup>b</sup>	7.57 $\pm$ 0.89 <sup>a</sup>
G 5 ( 15% PP powder)	4.77 $\pm$ 0.05 <sup>b</sup>	7.66 $\pm$ 0.67 <sup>a</sup>

## The Effect of PP at Different Levels on Serum Concentrations of Malondial-dehyde and Antioxidant Activity of Lead Intoxicated Rats

Results in Table (6) showed the effect of PP powder at different levels on serum concentrations of antioxidant activity such as CAT and SOD. Results showed that there were a significant decrease in serum SOD and CAT in the positive control group with a mean value  $67.35 \pm 16.46$  U/ mg and  $0.57 \pm 0.02$  u/mg, respectively when compared with the negative control group ( $88.71 \pm 14.64$  u/mg and  $0.67 \pm 0.005$  u/mg). However, serum CAT and SOD increased significantly ( $P < 0.05$ ) in groups 3, 4 and 5 significantly when compared with the positive control group. Moreover, the best value of SOD and CAT was noted in group 5. On the other hand, results showed that there was an increase of malondialdehyde significantly in the positive control group when compared to the negative control group. Serum MDA in groups 3, 4 and 5 groups were decreased significantly ( $P < 0.05$ ) when compared with the positive control group. Also, the best value of MDA was noted in group 5.

SOD is considered a front line of defense against the potentially cytotoxic  $O_2^-$  free radicals that cause oxidative stress (Mallikarjuna et al., 2008). Superoxide dismutase transforms  $O_2^-$  to the more stable hydrogen peroxide ( $H_2O_2$ ), which is converted enzymatically into  $H_2O$  by catalase and glutathione peroxidase (Czako' et al., 2007).

Crucial components of the antioxidant defense system in the body are cellular antioxidant enzymes (CAT and SOD), which are involved in the reduction of reactive oxygen species (ROS) and peroxides produced in the living organism in addition to the detoxification of certain compounds of exogenous origin, thus playing a basal role in the maintenance of balanced redox status. Induction of antioxidant enzymes has been suggested to reflect an enhancement in cellular protection, ensuring that potential oxidants are metabolized and eliminated more rapidly. In study by Chang et al., (2008) showed the protective effect of *Physalis peruviana* against



liver injury in rats might have been manifested by maintaining the hepatic SOD level, and enhancing the concentrations of CAT and GPx. In addition to the active compounds present in *Physalis peruviana* may have biological significance in the elimination of reactive free radicals (Wu et al., 2005). These results also suggest that the inhibition of serum transaminase elevation and hepatic damage may play an important role in the protective effect of PP to induced hepatocellular destruction.

Our results are in the same line with Chang et al., (2008) and Abd El-Rahman et al., (2016) whose demonstrated that there is a decrease in the level of lipid peroxides in the liver also, pre-treatment of PP led to an increase in CAT, SOD, and GPx levels in this organ. Antioxidant enzymes such as SOD, CAT, GPx, GRd, and GST, as well as glutathione as a nonenzymatic antioxidant substance, were elevated in serum when rats intake PP in the study by Ebtisam et al., (2014).

MDA was one of the main lipid peroxidation products, its elevated levels could reflect the degrees of lipid peroxidation injury in hepatocytes, and consumption of physalis markedly decreases MDA levels indicating its anti-peroxidative effect this results by Ebtisam et al., (2014) in the same line with our results.

**Table (6): The effect of PP at different levels on serum concentrations of malondialdehyde and antioxidant activity lead intoxicated rats.**

Mean values in the same column sharing the same superscript letterers are not statistically significant,  $P \leq 0.05$ . Parameters (Mean  $\pm$ SE)

Parameters Groups	SOD (U/mg protein)	CAT (nmol/min/mg protein)	MDA (nmol/min/mg protein)
G 1 (- Ve control)	88.71 $\pm$ 14.64 <sup>ab</sup>	0.67 $\pm$ 0.005 <sup>b</sup>	0.60 $\pm$ 0.07 <sup>b</sup>
G 2 (+Ve control)	67.35 $\pm$ 16.46 <sup>c</sup>	0.57 $\pm$ 0.02 <sup>c</sup>	0.86 $\pm$ 0.07 <sup>a</sup>
G 3 ( 5% PP powder)	74.84 $\pm$ 2.54 <sup>b</sup>	0.70 $\pm$ 0.008 <sup>b</sup>	0.64 $\pm$ 0.044 <sup>b</sup>
G 4 ( 10% PP powder)	91.39 $\pm$ 10.17 <sup>a</sup>	0.69 $\pm$ 0.01 <sup>b</sup>	0.62 $\pm$ 0.02 <sup>b</sup>
G 5 ( 15% PP powder)	97.16 $\pm$ 11.13 <sup>a</sup>	0.86 $\pm$ 0.04 <sup>ba</sup>	0.57 $\pm$ 0.04 <sup>b</sup>

### The effect of PP at different levels on serum concentrations of lead in lead intoxicated rats

Results showed that serum level of lead was increased significantly when rats were exposed to lead toxicity (positive control group) with a mean value of 486.66 $\pm$ 46.66  $\mu$ g/dL compared with the negative control group (216.66 $\pm$ 44.095  $\mu$ g/dL). When rats were fed on PP at different levels of intake, the lead concentration in serum was significantly decreased in all groups with the mean value of 336.66 $\pm$ 18.55  $\mu$ g/dL, 323.33 $\pm$ 38.44  $\mu$ g/dL and 290.00 $\pm$  5.77  $\mu$ g/dL, respectively compared to the positive control group.

Major bioactive compounds of PP such as physalins (B, D, and F) and glycosides (such as myricetin-3-O-neohesperidoside), have been shown to possess anticancer activities. Phytochemical studies have isolated a number of compounds from physalis, such as ticloidine, phygrine, 28- hydroxywithanolide, and 4- $\beta$ -hydroxywithanolide E. Ethanol extract of physalis showed potent cytotoxic effect against Hep G2 cells, and its mechanism of action was found to relate to a

mitochondria-mediated apoptotic pathway (Wu et al., 2005) because this active component of PP can reduce lead toxicity.

**Table (7): The Effect of PP at different levels on serum concentrations of lead in lead intoxicated rats**

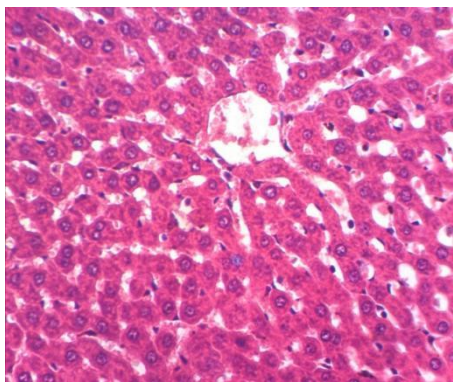
Mean values in the same column sharing the same superscript letterers are not statistically significant,  $P \leq 0.05$ . Parameters (Mean  $\pm$ SE)

Groups	Parameters	Lead ( $\mu\text{g}/\text{dl}$ )
G 1 (- Ve control)		216.66 $\pm$ 44.095 <sup>c</sup>
G 2 (+Ve control)		486.66 $\pm$ 46.66 <sup>a</sup>
G 3 ( 5% PP powder)		336.66 $\pm$ 18.55 <sup>b</sup>
G 4 ( 10% PP powder)		323.33 $\pm$ 38.44 <sup>b</sup>
G 5 ( 15% PP powder)		290.00 $\pm$ 5.77 <sup>bc</sup>

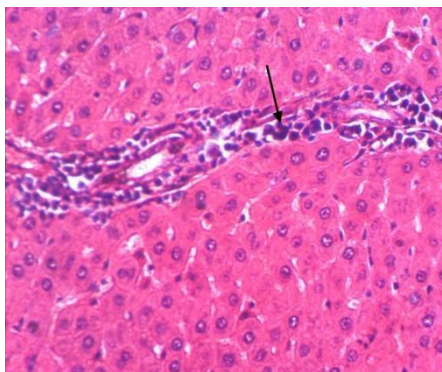
## Histopathological examinations

Histopathological observation revealed that PP could reduce the incidence of liver lesions. These results support that PP possesses hepatoprotective through its antioxidant activities and induced enhancement production of antioxidant enzymes. In addition PP was as good as vitamin C in total antioxidant activity

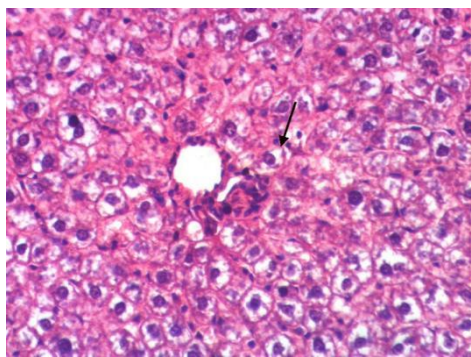
### Histopathological examination of liver



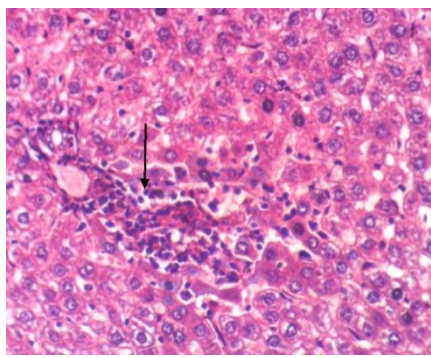
**Pho. (1):** Liver of rat from group 1 showing the normal histological structure of hepatic lobule (H & E X 400).



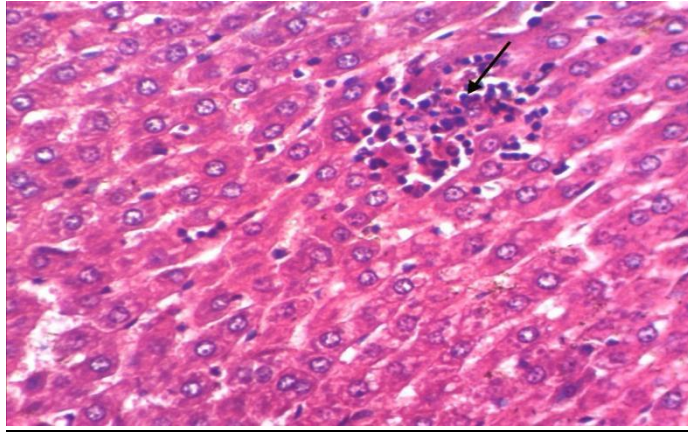
**Pho. (2):** Liver of rat from group 2 focal hepatocellular necrosis and apoptosis associated with mononuclear inflammatory cells infiltration (H & E X 400).



**Pho. (3):** Liver of rat from group 3 showing no changes except hydropic degeneration of hepatocytes

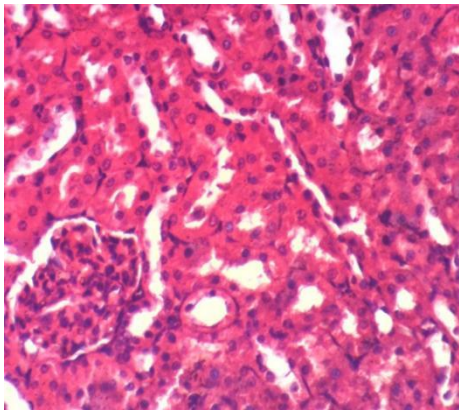


**Pho. (4):** Liver of rat from group 4 showing slight hydropic degeneration of some hepatocytes

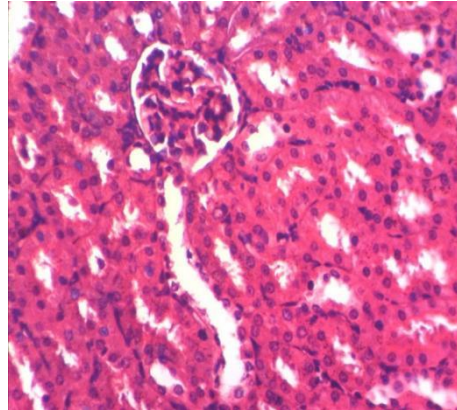


**Pho. (5):** Liver of rat from group 5 showing slight activation of Kupffer cells.

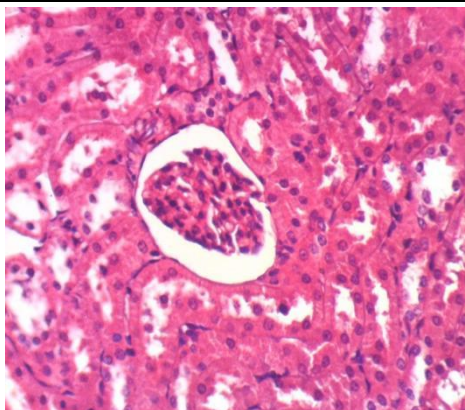
### Histopathological Examination of Kidneys



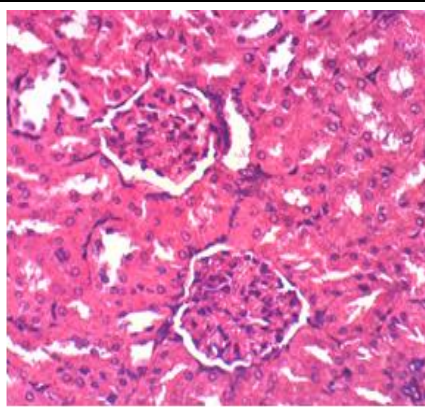
**Pho. (6):** Kidney of rat from group 1 showing the normal histological structure of renal tissue



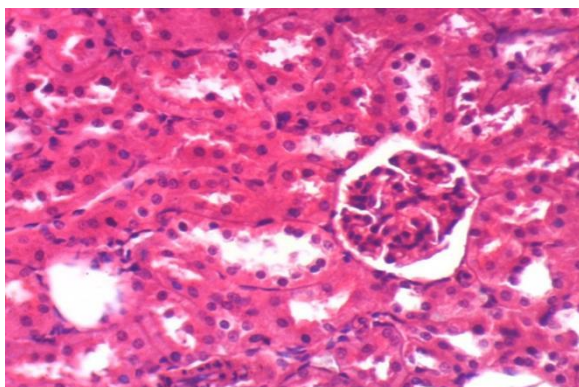
**Pho. (7):** Kidney of rat from group 2 showing vacuolization of epithelial lining renal tubules.



**Pho. (8):** Kidney of rat from group 3 showing no histopathological alterations.



**Pho. (9):** Kidney of rat from group 4 showing no histopathological alterations.



**Pho. (10):** Kidney of rat from group 5 showing no histopathological alterations.

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## الأهمية الغذائية للحرنكش وفعاليتها ضد تسمم الرصاص في الفئران

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### المستخلص العربي

أجريت هذه الدراسة لمعرفة الأهمية الغذائية للحرنكش وفعاليتها ضد تسمم الرصاص في الفئران. تم استخدام ثلاثون فأراً تتراوح أوزانهم ( 50 ± 5 جرام) تم تقسيمهم بعد فترة التكيف 6 أسابيع الى 5 مجاميع أساسية (6 فئران لكل مجموعة) المجموعة الأولى (6 فئران) استخدمت كمجموعة ضابطة سالبة بينما المجموعات الأخرى تعرضت للفئران فيها الى اسيتات الرصاص. المجموعة الثانية استخدمت كمجموعة ضابطة موجبة بينما الثلاث مجموعات الأخرى تغذوا على الغذاء الرئيسي المدعم بالحرنكش الجاف لثلاث مستويات ( 5 % , 10 % و 15 %) لمدة 6 أسابيع. تم حساب معدل الزيادة في الوزن. تم قياس كلا من الكالسيوم , الفوسفور , ALP , الرصاص وأنزيمات الكبد وتضمن الانين امينو ترانسفيريز (ALT) و أسبارتات امينو ترانسفيريز (AST)، بالإضافة إلى وظائف الكلى وتضمن نيتروجين اليوريا والكرياتينين في السيرم بالإضافة الى قياس إنزيمات مضادات الأكسدة وكذلك MDA وتم إجراء الفحوص التشريحية للأنسجة الكبدية والكلى. وقد أظهرت النتائج زيادة في زيادة وزن الجسم في المجموعات التي تم تغذيتها على الحرنكش مقارنة مع مجموعة الضابطة الإيجابية بينما انخفضت انزيمات الكبد معنويا في المجاميع الثلاث التي تناولت الحرنكش في المجموعه 3 و 4 و 5 على التوالي مقارنة مع المجموعة الضابطة الموجبة. قد تسبب الحرنكش في تحسن معنوي في تركيز مستوى الكالسيوم والفوسفور في الدم مقارنة مع مجموعة الضابطة الموجبة. هناك تأثير ضار بسيط للرصاص في

المجموعات الثلاث التي تناولت الحرنكش الجاف مقارنة بالمجموعه الضابطة الموجبة. تحسن مستوى نيتروجين اليوريا والكرياتينين فى المجموعات 3 و 4 و 5 على التوالي مقارنة مع المجموعة الضابطة الموجبة. كما أظهرت النتائج أن تركيز ALP انخفض بشكل معنوي عندما تناولت الفئران غذاء مدعم بالحرنكش فى المجاميع الثلاث مقارنة بالمجموعه الضابطة الموجبة. ولكن ارتفعت جميع انزيمات الاكسدة بشكل ملحوظ فى المجاميع الثلاث 3, 4 و 5 على التوالي. ومع ذلك ، انخفض MDA بشكل ملحوظ فى المجموعات 3, 4 و 5 ، على التوالي مقارنة مع المجموعه الضابطة الموجبة. وهكذا خلصت هذه الدراسة إلى تناول الحرنكش الجاف بثلاثة مستويات له تأثير جيد على الصحة من خلال الحد من التأثير السام الناتج عن المعادن الثقيلة وخاصة الرصاص.

**الكلمات المفتاحية:** تسمم الرصاص ، الحرنكش ، انزيمات الكبد، انزيمات مضادات الأوكسدة، نيتروجين اليوريا ، الفئران.