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Research Article

# Renoprotective, Hypoglycemic, and Hypolipidemic Effects of Argan (*Argania Spinosa* L.) Oil on Male Rats Exposed to Cadmium

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## Abstract

The protective and health benefits of various plant oils as renoprotective, hypoglycemic, and hypolipidemic agents are recently receiving considerable attention. The objective of the present study is to evaluate the protective effect of argan oil on male rats exposed to cadmium (Cd). In this study, 48 male rats were equally allocated into 4 groups. Rats of the first group (G1) served as normal controls. Rats of the second group (G2) were orally given 5mg/kg body weight cadmium chloride day after day. Rats the third group (G3) were orally administered with 700 mg/kg body weight argan oil and after three hours gave the same dose of cadmium chloride given to group two. Rats of the fourth group were orally supplemented with the same dose of argan oil given to group three. After six weeks of treatment, aassessments of fasting blood glucose, and serum urea nitrogen, uric acid, creatinine, low density lipoprotein-cholesterol (LDL-c) and high density lipoprotein-cholesterol (HDL-c) were performed in control and cadmium-intoxicated rats. Rats exposed to Cd showed increased levels of serum uric acid, creatinine and LDL-c compared with the normal control group. Alterations in the studied parameters were observed in cadmium-intoxicated rats administered with argan oil. Supplemented cadmium-intoxicated rats showed near normal biochemical profile and well preserved renal histology that substantiate the renoprotective, antihyperglycemic, and antihyperlipidemic effects of argan oil in rats exposed to cadmium chloride.

**Keywords:** Argan Oil; Cadmium; Nephropathy; Hypoglycemic; Hypolipidemic Effect

## Introduction

Pollution is the discharge of potentially harmful chemicals or substances in the surrounding environment, (particularly air, soil and water) by human in amounts that could pose health hazards [1]. Nowadays, pollution of the environment is underestimated and overlooked as a major cause of health issues. Statistics showed that pollution is the cause for around 7 million deaths per year [2]. Deaths caused by pollution exceed the total deaths caused by major diseases such as malaria, HIV/AIDS, and tuberculosis collectively [2]. The harmful consequences of pollution are usually overlooked on an international scale, where health assistance programs usually focus on infectious diseases [3].

There are economic repercussions to diseases caused by pollution, in terms of increased expenditure on healthcare and loss of productivity of individuals [3]. The widespread pollution can result in adverse health effects, including damage to the brains, lungs, and other organ systems, for large numbers of persons [4]. This damage can result in diminished economic productivity of entire countries [3].

One of the forms of pollution is contamination of food with heavy metals, where their accumulation pose a serious hazard through their bad effect on the health of both humans and animals [5]. The presence of heavy metals in the environment at elevated

level poses health hazards on the reproductive system, the cardiovascular system, blood forming cells, brain and kidney functions [6]. The contiguous use of chemicals in agricultural and industrial purposes increase the concentration of heavy metal in the environment. Pollution of the food with heavy metal contaminants can easily occur if the soil, plants or water used for production [7]. Toxic heavy metals pollution has increased recently due to the extensive industrialization, leading to atmosphere severe contamination [8,9].

Cadmium is a soft and bluish-white in appearance. It is an important component of batteries, cadmium pigments and plating. It is also used in plastics as a stabilizer for many chemical products, coating of metals, manufacturing of alloys, semiconductors manufacturing, picture tubes in televisions, as well as in molecular biology to antagonize voltage-dependent calcium channels. Cadmium is a highly toxic metal, it plays an important role in industrial occupation. In present time, it is even more significant as environmental pollutant [10]. Cadmium exposure is common among workers in the mining industry, thus, it poses a health hazard to humans. Chronic exposure to cadmium can have negative effects, such as lung cancer, weak bones, inflammatory lesions of the prostate in males, renal insufficiency, hypertension and damage to the cardiac muscles and the liver [11,12]. It can stay in the human body for tens of years as it neither can be effectively sequestered nor metabolized. Consequently, it may play a role in a variety of diseases, including diabetes, cancer, or heart disease [13].

Cadmium accumulated in basil, ginger, turmeric, lemon grass, parsley, onion, and coriander glory [11]. Soil containing heavy metals can threaten human health through consumption of vegetables, and the low-level intake of soil metals over extended period of time through consumption or inhalation has a negative effect on the human's health [14]. Cadmium has a very high potential to elevate oxidative stress in the cells by enhancing the production of reactive oxygen species (ROS) and hampering the antioxidant mechanisms. The toxicity caused by cadmium is mainly due to the formation of complexes with sulphydryl group of several enzymes and proteins, thus, causing conformational changes in the three-dimensional figure or by taking the place of the divalent metal cations in their catalytic pockets which are mainly needed by main proteins or enzymes as cofactors for their maximal biochemical activity [10].

Natural products from plants, animals and minerals have been the basis of the treatment of human disease. Today, it is estimated that about 80% of people in developing countries still relays on traditional medicine based largely on species of plants and animals for their primary health care [15]. Herbal medicines are currently in demand and their popularity is increasing yet again day by day. Plant species with medicinal uses are mentioned in ancient literature and many of these plants have been used in indigenous systems of medicine in many countries [16].

Medicinal plants and their products are a source of a wide variety of natural antioxidants and are used for the treatment of diseases throughout the world [17]. (Some of these properties include antimicrobial, anti-cancer, anti-diabetic, anti-atherosclerosis, immune-modulatory, and even reno-protection or hepato-protective effects [18]. In developing countries, traditional medicine is used directly to elevate the socio-economic status of the rural communities as well as their wellbeing [19]. Medicinal plants are regarded as an acceptable, cheap, easily available and safe source of bioactive compounds for treatment of various diseases [20].

The oleaginous argan tree (*Argania spinosa*) is known to be indigenous to the Sahara desert, the south western Moroccan areas of the Anti-Atlas and the High Atlas Mountains. It belongs to the family of *Sapotaceae* [21]. Argan oil popularity has increased over the centuries because of its therapeutic values, which have been reported in the literature since 1219 by the prominent Arab doctor, Ibn Baytar when he was the first physician to mention the argan tree in his writings [22].

Conventionally, argan oil was commonly used in Morocco topically to treat various conditions, such as dryness of the skin, psoriasis, acne, eczema, wrinkling of the skin, pain in the joints, and dermatitis. Dryness of hair and hair loss can both be treated with argan oil. Ingestion of argan oil can protect the liver and reduce bad cholesterol in the blood which causes atherosclerosis [23]. Countries in North America, Europe, and Japan started selling argan oil that can be ingested. Different extraction methods, such as cold press technique, hand extraction, and solvent extraction can be deployed according to the purpose of use of the oil (medicinal, cosmetic, culinary, etc…), where the final composition of the oil differs according to the method used. Different names have been given to argan oil, based on its purpose, such as cosmetic argan oil, virgin

argan oil, cold-pressed argan oil, and so on [24]. The current study aimed to investigate the renoprotective, antihyperglycemic, and antihyperlipidemic protective effects of Argan (*Argania spinosa* L.) oil in male rats exposed to cadmium chloride.

## Material and Methods

### Aragn oil

The plant oil (argan oil) used in this study was selected after an extensive ethnobotanical survey that involved interviewing traditional healers and literature survey. Argan oil was obtained from Rabat City, the Kingdom of Morocco.

### Experimental animals

Forty-eight male Wistar rats (100 - 120 g) were supplied by King Fahad Centre for Medical Research, King Abdulaziz University, Jeddah, Saudi Arabia. The experimental animals were acclimatized to the laboratory conditions for one week prior to the initiation of the experiments. Rats were housed in well-aerated standard plastic cages and maintained under controlled laboratory conditions of humidity (55% ±10), constant room temperature (20 ± 2 °C) and 12:12 h light: dark cycle each day. Rats were fed with standard laboratory chow diet ad libitum with free access to water. Animal handling and the experimental treatments were conducted in accordance with the Ethical Guidelines of the Animal Care and Use Committee of King Abdulaziz University, Jeddah, Saudi Arabia.

### Experimental design

Rats were randomly divided into four equal groups (n =12/ group). The treatment (argan oil) was given orally to the respective groups once a day for a period of 6 weeks. The normal and cadmium-intoxicated groups were as follows:

- **Group I**: Uuntreated rats and served as controls.
- **Group II:** Rats were orally given 5mg /kg body weigh cadmium chloride day after day.
- **Group III:** Rats were orally administered with 700 mg/kg body weight argan oil and after three hours gave the same dose of cadmium chloride given to group II.
- **Group IV:** Rats were orally supplemented with the same dose of argan oil given to group III.

### Samples collection

At the end of the experimental period, rats were fasted for 10 hours, water was not restricted, and then anaesthetized with diethyl ether. Blood samples were collected from orbital plexus veins in non-heparinized tubes, and then centrifuged at 3000 rpm for 15 minutes for serum separation. The blood sera were then collected, frozen at -80 ° C and stored until use for the biochemical analysis.

### Measurement of blood glucose

Rats were fasted for 8 hours, then blood glucose levels were estimated by taking blood samples from the tail vein using Free Style Freedom Lite, Abbott [25]. Thereafter, blood glucose levels were measured at the end of the experiment.

### Measurement of serum urea, uric acid, creatinine, low density lipoprotein and high Measurement of density lipoprotein

The serum urea, uric acid, creatinine, LDL-c and HDL-c levels were measured in cadmium-intoxicated rats by an autoanalyzer using diagnostic (My Bio Source, USA). Kits according to the manufacturer's instruction.

### Assessment of histopathological changes

The formalin-fixed kidneys from all groups were dehydrated in increasing grades of isopropyl alcohol and cleared in xylene. The slides were stained with Hematoxylin and Eosin (H and E) and examined microscopically for any histopathological changes in the kidneys.

### Statistical analysis

The obtained data in this study were expressed as mean ± standard error (SE). Statistical significance of the difference between groups, with more than two categories, was determined by one-way analysis of variance (ANOVA) followed by Least Significant Difference (LSD) post-hoc test. The statistical software package used for analysis was Statistical Package for Social Sciences (SPSS 24). The values were considered significantly different when the P value was $< 0.05$ and highly significant when the P value was $< 0.001$.

## Results

### Effect of argan oil on fasting blood glucose (FBG) levels

Figure 1 showed a non-significant ($p \geq 0.05$) difference in the levels of fasting blood glucose of cadmium-intoxicated rats (G2) and the normal control group (G1). On the other hand, the daily oral administration of argan oil at a dose of 700 mg/kg body weight to cadmium-intoxicated rats (G3) induced a significant decrease ($p \leq 0.05$) in the fasting blood glucose levels as compared with the normal control group (G1). Similarly, the treatment of cadmium-intoxicated rats (G3) with argan oil (G3) resulted in a significant decrease ($p \leq 0.01$) in the fasting blood glucose levels as compared with the cadmium-intoxicated rats (G2).

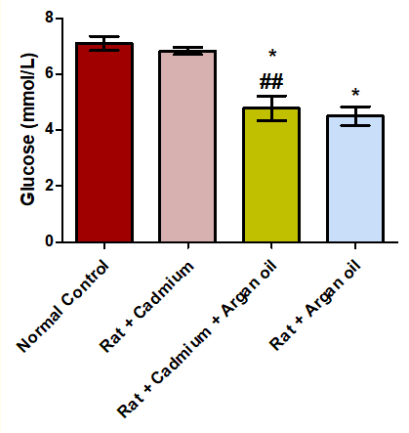


**Figure 1:** Effect of daily oral administration of argan oil on fasting blood glucose levels in normal and cadmium-intoxicated rats, measured after 6 weeks of cadmium poisoning.
Results are expressed as mean ± SEM (n=12). Mean value is significantly different at $p \leq 0.05$* compared with the normal control group. Mean value is significantly different at $p \leq 0.01$# compared with the cadmium-intoxicated group.

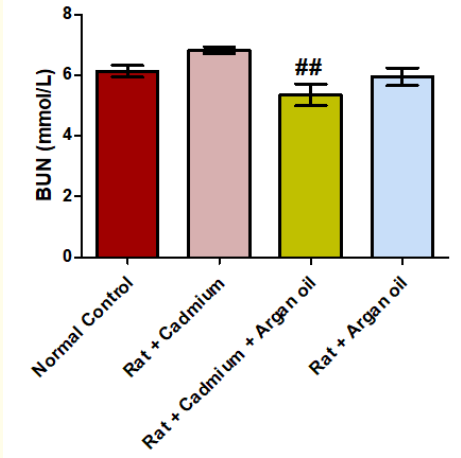


**Figure 2:** Effect of daily oral administration of argan oil on serum BUN levels in normal and cadmium-intoxicated rats, measured after 6 weeks of cadmium poisoning. Results are expressed as mean ± SEM (n=12).
Mean value is significantly different at $p \leq 0.01$## compared with the cadmium-intoxicated group.

### Effect of argan oil on serum blood urea nitrogen (BUN) levels

The levels of serum blood urea nitrogen showed a non-significant ($p \geq 0.05$) change in the cadmium-intoxicated rats (G2) as compared with the normal control group (G1). Similarly, the daily oral administration of cadmium-intoxicated rats (G3) with argan oil at a dose of 700 mg/kg body weight induced a non-significant ($p \geq 0.05$) difference in the serum blood urea nitrogen as compared with the normal control group (G1). Conversely, the daily gavage of cadmium-intoxicated rats in argan oil (G3) resulted in a significant decrease ($p \leq 0.01$) in blood urea nitrogen levels in comparison with the cadmium-intoxicated rats (G2) (Figure 2).

### Effect of argan oil on serum uric acid levels

The serum uric acid levels of cadmiu-intoxicated rats (G2) revealed a significant increase ($p \leq 0.01$) as compared with the normal control group (G1). On the other hand, the daily oral administration of argan oil at a dose of 700 mg/kg body weight to cadmiu-intoxicated (G3) showed a non-significant difference in serum uric caid levels in comparison with the normal control group (G1). Simlarly, treatment of cadmium-intoxicated rats (G3) with argan oil exihibited a non-significant change in serum uric acid levels in comparison with the cadmium-intoxicated rats (G2) (Figure 3).

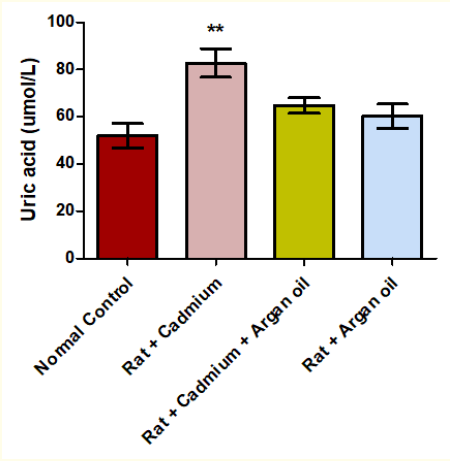


**Figure 3:** Effect of daily oral administration of argan oil on serum uric acid levels in normal and cadmium-intoxicated rats, measured after 6 weeks of cadmium poisoning. Results are expressed as mean ± SEM (n=12). Mean value is significantly different at $p \leq 0.01$** compared with the normal control group.

### Effect of argan oil on serum creatinine levels

Data presented in figure 4 clearly showed that there is a highly significant increase ($p \leq 0.001$) in the levels of serum creatinine of cadmium-intoxicated group (G2) when a comparison was made with the normal control group (G1). Treatment of cadmium-intoxicated (G3) with argan oil at a dose of 700 mg/kg body weight induced a non-significant change in the levels of serum creatinine in comparsion with the normal control group (G1). Simarly, cadmium-intoxicated rast (G3) gavaged in argan oil showed a non-significant change in the levels of serum creatinine as compared with the cadmium-intoxicated group (G2).

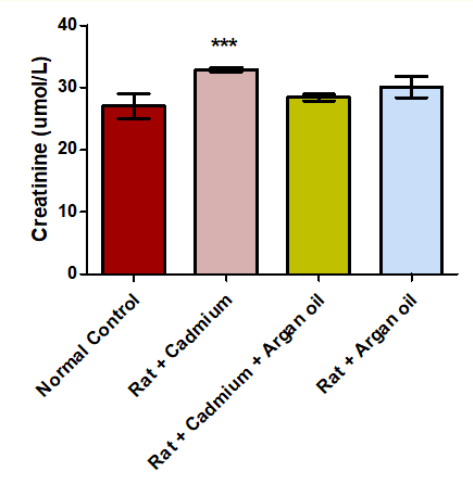


**Figure 4:** Effect of daily oral administration of argan oil on serum creatinine levels in normal and cadmium-intoxicated rats, measured after 6 weeks of cadmium poisoning.

Results are expressed as mean ± SEM (n=12). Mean value is significantly different at $p \leq 0.001$*** compared with the normal control group.

### Effect of argan oil on serum low density lipoprotein (LDL-c) levels

A comparison of serum LDL-c levels is illustrated in figure 5. The serum LDL-c levels of cadmium intoxicated rats (G2) exhibited a highly significant increase ($P \leq 0.001$) in comparison with the normal control group (G1). Similarly, the cadmium intoxicated rats treated with argan oil (G3) at a dose of 700 mg/kg body weight showed a significant increase ($P \leq 0.01$) in the levels of serum LDL-c as compared with the normal control group (G1). Moreover, the results of the present study indicated that the daily oral administration of cadmium intoxicated rats with argan oil resulted in a non-significant changes in the serum LDL-c levels as compared with the cadmium intoxicated group (G2).

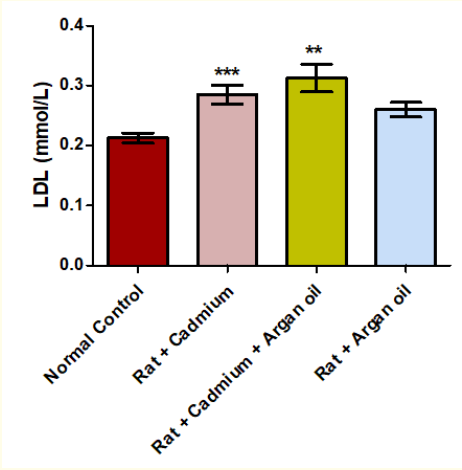


**Figure 5:** Effect of daily oral administration of argan oil on serum LDL-c levels in normal and cadmium-intoxicated rats, measurAed after 6 weeks of cadmium poisoning.

Results are expressed as mean ± SEM (n=12). Mean value is significantly different at $p \leq 0.01$**; $p \leq 0.001$*** compared with the normal control group.

### Effect of argan oil on serum high density lipoprotein (HDL-c) levels

The serum HDL-c levels of cadmium-intoxicated rats (G2) showed a non-significant ($p \geq 0.05$) changes as compared with the normal control group (G1). In addition, the results of the present study indicated that after 6 weeks of cadmium poisoning the HDL-c levels in cadmium-intoxicated rats treated with argan oil (G3) at a dose of 700 mg/kg body weight resulted in a highly significant increase ($p \leq 0.001$) as compared with the normal control group (G1). The daily gavage of argan oil to the cadmium-intoxicated rats (G3) exhibited a non-significant ($p \geq 0.05$) differences in serum HDL-c levels as compared with the cadmium-intoxicated (G2) (Figure 6).

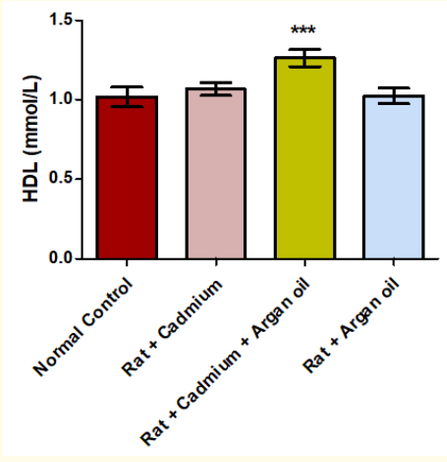


**Figure 6:** Effect of daily oral administration of argan oil on serum HDL-c levels in normal and cadmium-intoxicated rats, measured after 6 weeks of cadmium poisoning. Results are expressed as mean ± SEM (n=12). Mean value is significantly different at ≤ 0.001*** compared with the normal control group.

## Effect of argan oil on kidney histopathology

In the normal control kidney section, the cortex showed normal renal corpuscles with regular outer Bowman capsule (white arrows) and intact glomerular capillaries (GC) with normal cell density (Figure 7, Control: Cortex). Kidney tubules showed intact cuboidal epithelium and narrow lumina (black arrows). The medulla showed normal kidney tubules with narrow lumina and intact cuboidal lining epithelium (black arrows) (Figure 7, Control: Medulla).

In the kidney of cadmium-intoxicated rats, the cortex showed deformed renal corpuscle (white arrow) with lobulated fibrosed glomerular capillaries (GC) and marked decrease in cell density (hypocellurarity) (Figure 7, Cadmium: Cortex). The kidney tubules showed degenerated epithelial lining, dilated lumina filled with hyaline or cellular casts (black arrows). The medulla had a marked atrophy of lining epithelium with dilated lumina filled with hyaline or reticulated casts (black arrows) (Figure 7, Cadmium: Medulla).

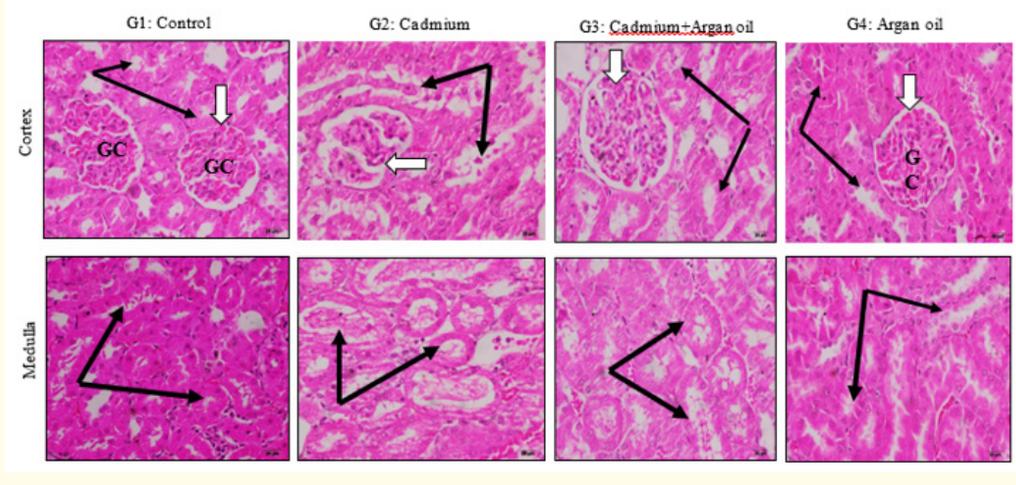


**Figure 7:** Photographs from rat kidney at cortex region stained by H and E:
G1. Control: cortex: Normal renal corpuscles with regular outer Bowman capsule (white arrows) and intact glomerular capillaries (GC) with normal cell density. Kidney tubules showed intact cuboidal epithelium and narrow lumina (black arrows). Medulla: showed normal kidney tubules with narrow lumina and intact cuboidal lining epithelium (black arrows).
G2: Cadmium toxicity: cortex: deformed renal corpuscle (white arrow) with lobulated fibrosed glomerular capillaries (GC) with marked decrease in cell density (Hypocellurarity). Kidney tubules showed degenerated epithelial lining, dilated lumina filled with hyaline or cellular casts (black arrows). Medulla: marked atrophy of lining epithelium with dilated lumina filled with hyaline or reticulated casts (black arrows).
G3: Cadmium toxicity + argan oil: Cortex: with normal large corpuscle (white arrow) with normal glomerular capillaries (GC) and normal cellularity. Medulla: Kidney tubules looked preserved (black arrows) with intact epithelial lining. Absence of luminal casts seen in toxic group.
G4: Argon oil: cortex: similar to G1: control group with no changes in eitheralmrenal corpuscle (white arrows) of kidney tubules. Medulla: also preserved kidney tubules structure with no histological changes. (H&E x600 Bar = 20µ).

In the kidney section of cadmium-intoxicated rats rats treated with aragn oil at a dose of 700 mg/kg body weight, the the cortex showed deformed renal corpuscle( white arrow) with lobulated fibrosed glomerular capillaries (GC) and a marked decrease in cell density (Hypocellurarity) (Figure 7, Cadmium+Argan: Cortex). Kidney tubules showed degenerated epithelial lining, dilated lumina filled with hyaline or cellular casts (black arrows). Medulla raveled marked atrophy of lining epithelium with dilated lumina filled with hyaline or reticulated casts (black arrows) ((Figure 7, Cadmium+Argan: Medulla).

In the kidney sections of normal rats administered with argan oil, the cortex revealed normal histo-morphology of eitheralmrenal corpuscle (white arrows) of kidney tubules (Figure 7, Normal: Cortex). The medulla showed preserved kidney tubules structure with no histological changes (Figure 7, Normal: Medulla).

## Discussion

Natural and anthropogenic activities are causing contamination of the environment and its resources by discharging heavy metals more than it can handle [26]. One of the forms of pollution is contamination of food with heavy metals, where their accumulation pose a serious hazard through their bad effect on the health of both humans and animals [5]. Although some heavy metals are found in trace amount, but still they cause serious health problems to human and other mammals [27]. Cadmium is a heavy metal that found as a natural constituent in earth's crust along with Copper, Lead, Nickel and Zinc. Cadmium is used in batteries, coating, plating, alloys etc. in various industries [28]. Plants have been the traditional source of raw materials for medicines since long time [29]. Natural bioactive compounds as phenol, flavonoids, alkaloids, and tannins found in the medicinal plants protect the biological systems against diseases [30, 31]. The argan tree is known to be indigenous to the semi-desert areas of South-western Morocco, it belongs to the family of *Sapotaceae*. It is an important forest species which can grow up to 8-10 meters high. The tree is resistant to drought and heat [32].

Argan oil is either of cosmetic or food grade. There has been an increase in the use of argan oil, either by itself or as an ingredient in many cosmetic preparations by dermatologists. Argan oil is copper-colored edible oil, which presents a slight hazelnut taste and nutty flavor. The kernels of *Argani spinosa* fruit are roasted in its preparation. Argan oil is an important source of fat in Amazigh diet and usually women prepare it [33]. Its preparation is a seven steps process, starting by picking the fruit, peeling, craking the nut, roasting and grinding the kernel, mixing of the dough and finally its collection.

The results of the present study demonstrated that the levels of fasting blood glucose in cadmium-intoxicated rats showed non-significant ($p \geq 0.05$) changes as compared with the normal control group. These findings are in accordance with Hasan., *et al*. [34] who concluded that short time exposure to cadmium (50 mg/kg bw) seems to have no direct effects on glucose metabolism in rats. In contrast six weeks administration of argan oil at a dose of 700 mg/kg body weight revealed a significant decrease in fasting blood glucose level in cadmium-intoxicated rats. The results of this study are in agreement with the previous reports that demonstrated the hypoglycemic effect of medicinal plants on blood glucose levels in rats exposed to cadmium [35,36]. The antihyperglycemic effect of various bioactive compounds found in medicinal plants can improve glucose absorption and prevent hyperglycemia by several mechanisms, such increased inhibitory effects against insulinase, decreased liver inflammation, and improved insulin sensitivity [34]. In addition, the hypoglycemic effect may be due to other mechanisms involved, such as inhibition of glucose absorption in the intestine, increased peripheral glucose utilization, synthesis of glycogen in the liver, or decreased glycogenolysis [37-40]. Uric acid is the end product of purine catabolism, and its increase in blood serum signifies renal functional impairment. Urea is the end product of protein catabolism in the living system. It is synthesized in the liver from ammonia, which is formed as a result of deamination of amino acids. Creatinine is a metabolic derivative of muscle creatinine and phosphocreatine. The amount of creatinine is usually stable, and its high level indicates a decrease in renal function, since it is easily excreted by the nephrons [41].

In the current study, there was a significant increase in serum uric acid and creatinine levels of cadmium-intoxicated rats as compared with the normal control group. The argan oil had no direct effects on uric acid and creatinine levels of cadmium-intoxicated rats but, it had beneficial effects on blood urea nitrogen. The findings of the current study go parallel with that of Necib., *et al*. [42]. The authors noted that treatment with argan oil significantly reduced elevated serum urea levels and counteracted the harmful effects of mercury chloride on oxidative stress markers in rats. The au-

thors concluded that argan oil can play a beneficial role in the fight against nephrotoxicity caused by mercury chloride and oxidative stress in rats. The protective effect of argan oil may be due to its active constituents such as polyunsaturated and unsaturated fatty acid, polyphenols, tocopherols, sterols and ß -carotene. These bioactive compounds have been reported powerful antioxidants that provoke free radical scavenging enzyme system [42,43].

The biochemical analysis of lipid profile in the present work, revealed a significant elevation in the levels of serum LDL-c of rats exposed to cadmium in comparison with the normal control group. Moreover, daily oral administration of argan oil to cadmium-intoxicated rats resulted in a significant increase in the levels of serum HDL-c. Enhanced HDL-c is known to play an important role in the transportation of cholesterol from peripheral cells to the liver and is considered as a cardioprotective lipid. Several medicinal plants have been reported to play an important role in decreasing LDL-c and elevation of HDL-c levels in experimental animals exposed to heavy metals and pesticides [44-46]. Similar results were recorded by Aidoud., *et al*. [47]. The authors showed that hat ingestion of lycopene-enriched olive and argan oils reduced the levels of triglycerides (TC,) LDL-C, TG and phospholipids in rats, while HDL-C levels were increased in all groups assayed. In a similar experiment, serum triglycerides, total cholesterol, LDL- c, were decreased after argan oil intervention. However, HDL-c levels were increase in type 2 diabetic patients [48].

In this study the kidney of cadmium-intoxicated rats showed degenerative changes in renal corpuscle glomeruli mainfestd as glomeualr cappialriy atropy, lobulation and hypocelluraity. Kidney tubules are dilated due to epithelial lining degeneration or apoptosis (dark cells and nuclei). In addition, it contains hyaline or cellular casts. In agreement with this results, Das., *et al*. [49] showed a significant kidney pathological changes in cadmium-intoxicated rats as demonstrated by shrinkage of the glomerulus, thickening of the Bowman's capsule, and an appearance of the renal tubules when compared to the kidney section of the normal control group. Furthermore, these results are in general agreement with many previous studies that proved cadmium-induced kidney pathological alterations [50-53].

In contrast, the results of the present study indicated that, daily oral administration of argan oil to cadmium-intoxicated rats attenuated the aforementioned pathological changes in the kidney sections and restored renal tissue architecture near-normal levels. The observations of the current study are generally similar to that obtained by Bakour., *et al*. [46]. The authors reported that the hydrogen peroxide-induced histopathological changes have been significantly alleviated by argan oil. Moreover, the findings of the present study are in partial agreement with the results obtained by Alahmadi., *et al*. [54]. The authors indicated that treatment of lead-intoxicated rats with argan oil lightly debilitated kidney histological alteration induced by lead.

## Conclusion

The findings of this study evidently showed that argan oil pretreatment exerted protective effect against cadmium-induced nephrotoxicity in male rats as demonstrated by attenuation of the aforementioned biochemical parameters and pathological changes in the kidney sections and restored renal tissue architecture near-normal levels.

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