The Potential Protective Effects of Aqueous Extracts of Some Herbs on Renal Toxicity Induced by Formaldehyde in Experimental Rats

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ABSTRACT

The current study was performed to evaluate the protective effect of aqueous extracts of Corn silk and Asparagus Officinalis against renal toxicity induced by formaldehyde in rats. Thirty-six male albino rats with "Sprague Dawley" strain weighing (150±10 g) were used and split into 2 major groups, the first group (6 rats) fed on a basal diet and kept as a negative control, and the second group of 30 rats was injected with formaldehyde intraperitoneally (10 mg/kg BW /day on 14th to 28th day and divided into 5 subgroups. The first subgroup received a normal diet and acted as a positive control group. The second, third, fourth, and fifth categories consumed standard feed with oral dosages of 200 and 400 mg/Kg body weight per day of aqueous corn silk and asparagus aqueous extract respectively during a 28-day period. Body weight gain (BWG), Feed intake (FI), feed efficiency ratio (FER), and relative kidney weight were computed at the finish of the experiment. Assessment of some serum biochemical parameters, kidney tissues were analyzed for antioxidant/oxidant markers, and histopathology of kidneys were assessed. The results revealed that corn silk and Asparagus aqueous extracts improved the biological evaluation, kidney functions, liver functions, Serum electrolytes, antioxidant enzymes activity, and histopathology of kidneys compared to the positive group. In conclusion, the administration of corn silk and Asparagus aqueous extracts can lower the impacts of formaldehyde on kidneys.

Key words*: Corn silk, Asparagus, Formaldehyde**, kidney functions; antioxidant enzymes.*

INTRODUCTION

A healthy life requires preservation of the kidney, one of the body's key organs that performs the detoxification process. Few herbs have been examined for nephroprotection, yet it is frequently linked to a decrease in proteinuria. Numerous natural products, medicinal plants, and dietary components have been investigated as possible nephron-protective agents **(Kasabe *et al*., 2012).** Nephrotoxicity is the malfunctioning of kidney-specific detoxification and excretion as a result of endogenous or exogenous toxins damaging or destroying renal function. The kidney is a significant control mechanism that maintains the body's homeostasis and is frequently being toxic by drug exposure. As such, the kidney is particularly vulnerable to xenobiotics. Alteration in glomerular hemodynamics, rhabdomyolysis, tubular cell toxicity, crystal nephropathy, inflammation, and thrombotic microangiopathy are a few of the mechanisms for drug-induced nephrotoxicity (**Kim and Moon, 2012)**.

In its pure form, colorless formaldehyde (FA), which is extremely soluble in water, irritates. Owing to its widespread use in industries like the creation of building materials, textiles, the sterilization of goods, plastics, and cosmetics, FA is a contaminating substance that is frequently discovered in the environment **(Bakar *et al*., 2015)**. Additionally, most morgues and anatomy departments employ FA to preserve cadavers. **(Raja, 2012).** FA is a crucial intermediate for the production of purines and other amino acids, and it is also created endogenously by the L-methionine metabolism, methanol, histamine, and methyl alanine **(Checkoway *et al*., 2015)**. Reactive oxygen species can be produced and released as a result of the toxicity brought on by FA exposure through aerobic metabolism and inflammation (ROS) **(Gulec *et al*., 2006; Birben *et al*., 2012**). In albino rats that have been exposed to FA over a long period of time, the renal functions may gradually deteriorate. It's possible that urea, serum electrolytes, and creatinine are insufficient to detect early

kidney damage **(Olisah and Meludu, 2021).**

Corn silk (*Stigma maydis*) means that the stigmas come from the female flowers of corn, and fresh corn silk looks like soft silk threads about 10 – 20 cm long that are either light green or yellow-brown in color **(Sanusi *et al*., 2020)** and **(El-Seedy *et al*., 2022)** is generally discarded as waste due to the lack of utilization. It is important in attracting pollens, which are further transferred from the anther to the stigma during pollination **(Aukkanit *et al*., 2015)**. It is also contained lipids, vitamins, minerals, proteins, carbohydrates, and volatile oils **(Chutima *et al*., 2020)**. It also consists of various chemical components including polysaccharides, alkaloids, proteins, flavonoids, tannins, and steroids **(Dika *et al*., 2018)**. It has bioactive constituents for example terpenoids, and flavonoids **(Vijitha and Saranya, 2017)**. It has a variety of pharmacological actions that have been broadly described, including anti-inflammatory, anti-hyperlipidemic, anti-depressant, anti-diabetic, anti-fatigue, neuro-protective, antioxidant, kaluretic impacts, and anticancer effects **(Jia *et al*., 2020)** and **(Chutima *et al*., 2020**).

Additionally, cystitis, kidney stones, edema, prostate disorders, urinary infections, bedwetting, obesity, and as a diuretic are all conditions that can be treated with corn silk. Moreover, it has been suggested that using corn silk can help treat pleurisy and inflammatory disorders brought on by oxidative stress **(Wang *et al*., 2012).**

Asparagus (*Asparagus Officinalis*) is the hard stem and woody bottom of the asparagus stalk, and it is an enriched source of bioactive compounds **(Huang *et al*., 2022)**. It includes a variety of natural bioactive phytochemicals with diverse pharmacological actions **(Fathalipour *et al*., 2020)**. Asparagus is utilized in salads, soups, and vegetable dishes, and it has various uses in European and Asian traditional herbal medicine **(Huang *et al*., 2008)**. Pharmacological research has shown that *A. Officinalis* has anti-inflammatory, antifungal, antimutagenic, and diuretic effects.

Additionally, the plant's roots and sprouts are rich sources of oligosaccharides, flavonoids, steroidal saponins, and derivatives of amino acids **(Tzatzarakis *et al.*, 2017).** As per some research, *A. Officinalis* has biological properties that include reducing alcohol hangovers and defending liver cells from toxins **(Kim *et al.*, 2009)**. *A. Officinalis* may be utilized to treat diabetic nephropathy **(Somani *et al.*, 2012)**

The goal of the current investigation was to assess the renal protective efficacy of aqueous extracts of *Asparagus Officinalis* and corn silk *(Stigma maydis)* on formaldehyde-induced kidney toxicity in experimental rats.

MATERIALS AND METHODS

Materials

Dried corn silk was obtained from Agriculture Seeds, Herbs and Medicinal plants Company, Cairo, Egypt. *Asparagus Officinalis* was obtained from Carrefour market, in Tanta, Egypt. Thirty-six male albino rats (*Sprague Dawley strain*) were obtained from the Laboratory Animal Colony, Helwan, Cairo – Egypt, and weighting approximately between 150± 10g. Formaldehyde purity (37%) was supplied from Sigma chemical company. Corn oil and starch were purchased from the local market. Casein, cellulose, ingredients (vitamins, minerals), dextrin, L-cysteine, and choline chloride were obtained from the Cairo Company for Chemical Trading, Cairo, Egypt.

Methods

Preparation of corn silk extract

The plant extract was prepared according to the method used by **Saheed *et al.*, (2015)** exactly 100 g of corn silk was extracted by maceration in 1000 mL of distilled water. These heterogeneous mixtures were boiled with the aid of a heater for 4 hours at 100^{oC}. After boiling the sample, the filtrate was separated from the corn silk residue with the aid of Whatman no. 1 filter paper, and a funnel was placed into a beaker for separation. The resulting filtrate was concentrated to dryness.

Preparation of *Asparagus Officinalis* extract (AOE)

For the preparation of AOE, plants were air-dried at room temperature (25°C) the dried samples (100 g) were then extracted with 1 L of boiling distilled water for 2 h at 100 $^{\circ}$C, and then the extracts were passed through a filter. The resulting filtrate was concentrated to dryness and stored at −20 $^{\circ}$C until use, all the procedures were according to **(Pal *et al*., 2017).**

Experimental design

Thirty-six adult male albino rats *Sprague Dawley* strain weighting (150± 10g) were housed in well- aerated cages under a hygienic condition and were fed on a basal diet according to **Reeves *et al*., (1993)** for one week for adaptation. After this week, the rats were divided into two main groups: the first group (6 rats) fed on a basal diet and served as a negative control group. The second group (30 rats) was injected with formaldehyde purity (37%) intraperitoneally injection at a rate of 10 mg/kg BW/day for 14 days **(Zararsiza *et al*., 2006)** to induce nephrotoxicity from the 14th to 28th day. The second group was divided into 5 subgroups as follows: subgroup (1) was received a normal feed only and served as a positive control group. Groups (2, 3): were intake standard meal with added corn silk (200 and 400 mg / Kg body weight) respectively orally for 28 days **(Sepehri et al.,2011).** Groups (4, 5) were consumed major feed including *Asparagus Officinalis* (200 and 400 mg / Kg body weight) respectively orally for 28 days **(Jashni et al., 2016).** Body weight and feed intake were checked once a week. At the end, animals were weighed, fasted overnight, and then sacrificed under very light anesthesia.

Biological evaluation

At the end of the experiment, feed intake, body weight gain, relative organs weight, and feed efficiency ratio were calculated according to **Chapman *et al*., (1959).**

Biochemical analysis of serum

After the sacrifice of rats, blood samples were collected from the hepatic portal vein of each rat into dry clean centrifuge tubes.

Serum was carefully separated by centrifugation of blood samples at 3500 rounds per minute (rpm) for 15 minutes at room temperature, transferred into dry clean Eppendorf tubes, then kept frozen at - 20$^{\circ C}$ for later determinations. Serum samples were used for the determination of blood glucose was determined according to **Trinder, (1969)**. Serum tumor necrosis factor-α (TNF-α) was assayed as an inflammatory biomarker **(Luo *et al.*, 2005).** Uric acid, urea nitrogen, and creatinine were determined according to **Fossati *et al.*, (1980**), **Patton and Crouch (1977), Bartels *et al.*, (1972)** respectively. Aspartate aminotransferase (AST) was carried out according to the method of **Henry, (1974) and Yound, (1975).** Alanine aminotransferase (ALT) was evaluated according to **Bergmeyer *et al.*, (1986),** serum (ALP) was estimated according to the colorimetric method of **Roy (1970),** albumin according to **Drupt, (1974).** A total protein limited according to **Sonnenwirth and Jaret, (1980*).*** Globulin was calculated according to **Busher, (1990)** using the following equation:

Globulin = Total protein – Albumin.

Creatinine clearance (CrCl) as a marker to glomerular filtration rate (GFR) was calculated from serum creatinine (SCr) and urine creatinine (UCr) levels and 24-hour urinary volumes acceding to **Inker and Perrone (2021)** using the following equation:

GFR = [UCr x V] ÷ SCr

Sodium (Na^{+}), potassium (K^{+}), calcium (Ca^{++}) and Magnesium (Mg^{++}) were specified in the serum according to the method by **Berndt and Jackwerth, (1979).**

Organ's sampling

Kidneys were carefully separated from all rats, washed with saline solution (0.9%), dried with filter paper, and individually weighted. A specimen from the kidneys was frozen at (-20$^{\circ C}$) for preparing tissues homogenate to determine antioxidant activities. The homogenization was centrifuged at 1000 rpm for 10 min.

***Assessment of antioxidant activities and lipid peroxidation in the kidney tissues*:**

Antioxidant indications were assessed such as Superoxide dismutase (SOD) according to **Nishikimi *et al*., (1972)**. Catalase (CAT) by colorimetric assay as stated by **Sinha,** (1972). Lipid peroxide (LPO) as malondialdehyde (MDA) was assessed-estimated by colorimetric assay as maintained by **Buege and Aust,** (**1978),** Nitric oxide (NO) was determined according to **Cortas and Wakid,** (**1990).**

***Histopathological examination*:**

The kidney of each sacrificed rat was removed and fixed in a 10% neutral buffering formaldehyde solution with a pH of 7.5, then cleaned in xylol before being fixed in paraffin. For histological analysis, a 4-5 µm thick piece was cut and spotted with Hematoxylin and Eosin (H&E) (**Bancroft and Gamble, 2008).**

Statistical analysis:

One-way analysis of variance (ANOVA) was used, followed by the Duncan test, in SPSS software (18) to know the difference between means at $P < 0.05$. The data were presented as a mean ± standard deviation (SD) **(Snedecor and Cochran, 1989)**.

RESULTS

Biological evaluation

Feed intake (FI), body weight gain % (BWG), and feed efficiency ratio (FER) were shown in Table 1 have significantly decreased in the positive Control group compared to the normal group. However, the other treated groups have revealed a significant increase in all of them compared with the positive control group, and the best results were found in group Corn Silk (400 mg /kg BW) in FI, BWG, and the superior results for FER was recorded to Corn Silk and Asparagus (400 mg /kg BW).

Relative kidney weight

As shown in (Table 2), relative kidney weight has been decreased in the positive control group compared with the negative control group. However, it was significantly increased in all treated groups compared with the positive control group. The best results were recorded in Corn Silk and Asparagus (400 mg/kg BW) as it recorded a significant increase in

relative kidney weight compared with other investigated groups.

Kidney functions

The data in Table (3) indicated that mean values of creatinine, urea, uric acid, and Creatinine clearance in the positive control group were significantly higher compared with the negative dominance group. All parameters in remedy categories significantly decreased ($P<0.05$) compared to positive control set. The best findings in creatinine, urea and uric acid were found in the Corn Silk collection (400 mg/kg BW) while the preferable findings in Creatinine clearance were found in Corn Silk and Asparagus sets (400 mg/kg BW).

Serum electrolytes

Serum Na+ and K+ levels have increased in the renal dysfunction cohort versus the normal rats, as indicated in Table 4. In contrast to the ill rats, it was significantly lower in all different treatment groups. The most effective outcomes were noted with Corn Silk Set (400 mg/kg). While serum Ca++ and Mg++ levels in the G2 were lower than those in the G1. Although it was significantly higher in all rats treated compared to the positive control, Corn Silk and Asparagus sets (400 mg/kg) gave good results.

Blood glucose

The data presented in Table 5 showed that the ill group's mean blood glucose values were significantly greater than those of the normal group. In comparison to the positive control rats, every parameter in the different remediations decreased significantly (P 0.05). Corn Silk set (400 mg/kg BW) gave an improved result.

Liver functions

The data displayed in Table 6 showed that all remedy groups had considerably lower mean values of ALT, AST, and ALP compared to the ill group, while these values were significantly higher in the sick rats (G2) than in the healthy rats (G1). Good ALT, AST, and ALP results were seen in Corn Silk (400 mg/kg BW).

Serum Total protein, Albumin and Globulin

The results in Table 7 demonstrated that, in comparison to the G1, the mean value of total protein, albumin, and globulin significantly decreased in the G2. However, compared to the positive control group, every other investigated group experienced a considerable increase. When compared to the G2, the effects of asparagus at 200 mg/kg BW on total protein and albumin were non-significant. The groups treated with Corn Silk and Asparagus (400 mg/kg BW) had the highest levels of total protein, while the group treated with Corn Silk (400 mg/kg) had the best results for albumin and all of the treated groups had the great outcome for globulin due to their close similarity to the control group.

***Serum tumor necrosis factor -α (α –TNF) and antioxidant enzymes (CAT, SOD, malondialdehyde (MDA) and nitric oxide (NO in kidney tissue*.**

Table 8 showed that compared to the healthy group (G1), the activities of catalase (CAT) and superoxide dismutase (SOD) considerably decreased in the unwell group (G2), but they elevated in the therapy groups. Asparagus and Corn Silk (400 mg/kg BW) both had the best CAT results, while Corn Silk (400 mg/kg BW) had good SOD values. Further, the same table showed that, the mean values of TNF- α, MDA, and NO were significantly greater in the G2 than in G1; whereas their values were significantly lower in the other groups. Corn Silk (400 mg/kg) showed good results for TNF- α, MDA, and NO, whereas Corn Silk and Asparagus (400 mg/kg BW) showed the best improvements for MDA and NO.

Histological Results:

Histological sections of rat kidney showing the control group (A & B) with the normal histological structure of the renal cortex containing the glomeruli, proximal and distal convoluted tubules. The positive group (C & D) shows severe affection for the renal tubules with signs of tubular cell lining vacuolation (red arrow) and intratubular cast deposition (green arrow), tubular hydropic degeneration (yellow arrow) with congestion of the glomeruli (blue

arrow) and narrowing of the Bowman's space (black arrow). The Corn silk 200 (E & F) group shows congestion of the glomeruli (blue arrow) and intratubular hemorrhage (blue arrow). The Corn silk 400 group (G & H) shows fewer pathologic changes than the above group. The Asparagus 200 (I & J) shows tubular cell lining vacuolation (red arrow) with less marked glomerular congestion (blue arrow). The Asparagus 400 group (K & L) shows a more or less good picture than the above group.

DISCUSSION

The findings of the ongoing work are in line with **Wu *et al*., (2017)** who revealed that FA exposure induced a significant reduction in body weight in maternal mice, their offspring and body weights of newborns were significantly lower contrasted with the control group. These findings are in agreement with **Egwurugwu *et al*., (2018)** who observed that formalin-exposed rats reduced feeding habits causing weight loss contrasted with the normal control group. **Yogesh *et al*., (2013)** reported that the diets using corn silk at different levels elevated the body weight gain of rats with kidney stones disease compared with a positive control group. In this respect, **Kim *et al*., (2017)** found that oral administration of Corn Silk produced significantly elevated body weight gain, feed intake and FER. **Ikpeazu *et al*., (2018)** mentioned that oral administration of a boiled aqueous solution of *Stigma maydis* produced significantly increased body weight of the extract-medicated animals when contrasted to the positive control group. The ongoing findings are in harmony with **Zhang *et al*.**, **(2014)** who indicated that administration of aqueous extract *Asparagus Officinalis* significantly increased body weight compared with a positive control group.

The ongoing study's findings are in agreement with **Ha *et al*., (2018)** who found that rats administered with aqueous Corn silk extract showed increase of relative Kidney weights. Due to the fact that maize silk extract has a lot of phytochemicals that can produce diuresis and its diuretic action may lead to an elevation in

kidney weight. The present outcomes were supported by **Zhang *et al*., (2014)** who found that rats administered aqueous *Asparagus Officinalis L*. extract indicated a significant elevation in relative kidney weight contrasted with the untreated rats. This finding is emphasized by **Boj *et al*., (2003)** who demonstrated that statistically significant elevation in urea levels in the formaldehyde group contrasted with the normal rat group. The current results were supported by **Egwurugwu *et al*., (2018)** who indicated a statistically significant elevation in urea and creatinine's serum concentrations in the formalin-exposed rats when contrasted with the control group. Because several enzymes, notably NAD-dependent dehydrogenase formaldehyde, catalase, xanthine oxidase, and peroxidase, oxidize FA to formic acid. An increase in urea concentration has been linked to an elevation in the synthesis of these enzymes for the detoxification of FA. Sepehri et al. (2011) showed comparable outcomes, noting a significant reduction in serum creatinine in Corn silk + gentamicin groups contrasted to gentamicin groups in rats. These findings are in line with **Tanideh *et al*., (2018)** who showed that rats whose administration of aqueous corn silk extract caused significantly increased ~~of~~ creatinine clearance when compared with the non-treated group. These findings are emphasized by **Poormoosavi *et al*., (2018)** Who reported that administration of *Asparagus Officinalis* induced toxicity in rats improved serum levels of creatinine and urea nitrogen when contrasted with the non-treated group.

The results are in line with those of **Egwurugwu *et al*. (2018)**, who found that formalin-exposed rats had statistically significant duration-dependent increases in serum potassium and sodium concentrations when contrasted to the healthy control group. The formalin's dehydration and thirst's impacts may also be to blame for the rise in serum electrolytes in exposed rats. Antidiuretic Hormone (ADH) release is stimulated by dehydration, which results in higher serum osmolarity and electrolytes.

The current findings are in line with **Hasanudin *et al*., (2012)** who mentioned that the rat Corn silk treated group significantly increased Na+ excretion and increased K+ excretion due to its diuretic impacts, whereby the urine flow was elevated as diuretic impacts can lead to water and solutes' loss in the blood. **Kamel *et al*., (2014)** investigated that Rutin one of the phenolic compounds in *Asparagus Officinalis* administration could offer preservation versus cisplatin-induced nephrontoxicity. Where a recorded significantly reduced the levels of serum sodium and potassium in comparison with the cisplatin-treated group. This finding is supported by **Tan *et al*., (2018)** mentioned that injection of FA-induced hyperglycemia due to Formaldehyde interacts with insulin to form Formaldehyde-insulin adducts, and these Formaldehyde -insulin adducts induced insulin deficiency.

The current findings, which **Hasanudin *et al*. (2012)** confirmed, showed that administering Corn Silk extract does not raise blood glucose levels. These findings demonstrated that the mechanism of action of corn silk extract on glycemic metabolism is not through an increase in glycogen and inhibition of gluconeogenesis, but rather via an increase in insulin levels and recovery of the damaged cells. These results are in agreement with those found by **Ha *et al*., (2018)** and **El-seedy *et al*., (2022**) who revealed that significant decreases were recorded in glucose levels in rats fed on a diet containing corn silk. These results are in agreement with those found by **Dika *et al*., (2020)** who mentioned that giving corn silk led to a significant reduction in blood glucose concentrations in diabetic rats, because corn silk has many ingredients, including alkaloids, flavonoids, phenols, saponins, tannins, and sitosterol. The flavonoids in corn silk repair pancreatic β cells which can stimulate insulin secretion. These findings are consistent with those of **Zhang *et al.* (2014)** who found that *Asparagus Officinalis L*. effectively reduced hyperglycemia without increasing hepatic glycogen content or insulin

secretion. Other pathways include decreased serum glucagon, decreased levels of hepatic gluconeogenesis, decreased glucose absorption, and enhanced insulin sensitivity.

Results are supported by **Afrin *et al*., (2016)** who cleared those activities of AST, ALP, and ALT enzymes were significantly increased in group treated intraperitoneally injected with formaldehyde in comparison to a normal control group. Because of its metabolic reactivity, formaldehyde is a necessary metabolic step in all cells and is used in the manufacture of some purines, amino acids, and thymidine.

The findings of the ongoing work are in line with **Ikpeazu *et al*., (2018)** who found that dose-dependent increase was observed in AST and ALT significantly reduced in rats medicated with *Stigma maydis* (corn silk) when contrasted to control groups. These findings are in line with **Arba *et al*., (2020)** who noted that treating rats on diet containing different levels of Corn silk led to a significant decrease in serum ALT, ALP, and AST enzymes, as compared to the non-treated group. because corn silk contains phytochemicals that have beneficial effects, such as flavonoid compounds, which act as antioxidant agents and has a hepatoprotective effect.

These results are in line with those reported by **Al-Snafi (2015)**, who claimed that an aqueous asparagus extract's administration reduced serum levels of ALT, AST, and ALP. According to **Poormoosavi *et al.* (2018)**, *Asparagus Officinalis* aqueous extract significantly reduced the serum levels of (AST) and (ALT). *Asparagus Officinalis*'s tissue-protective properties are likely achieved by reducing G-SH depletion, limiting lipid peroxidation, and boosting antioxidative ability. As a result, Asparagus Officinalis is a viable option for defending tissues (such as the liver and kidneys) against numerous toxins due to its potency and effectiveness.

These outcomes are in line with **Chinedu *et al*., (2017)** who showed that short-term exposure to formalin induced a significant

decrease in the mean serum levels of albumin, and total protein when compared with before formalin exposure. In the subjects, these findings are in line with **Ha *et al*., (2018)** who cleared those rats medicated with Corn Silk was increased total protein and albumin when compared with rat untreated rat group.

These results agree with that **Persoz et al., (2010)** The researchers reported that FA has a stimulating impact on cytokines such as TNF-α, which affects inducible nitric oxide synthase (INOS) metabolism. **Egwurugwu *et al*., (2018)** who indicated that extended exposure to formalin can trigger several pathophysiological circumstances, such as inflammatory disorders by interfering in the natural killer (NK) cells and TNF's levels.

These outcomes are in line with **Sener *et al*., (2015)** who showed that rats in the formaldehyde group had higher NO than controls due to formaldehyde being is thought to increase NO synthesis through inducible nitric oxide synthase (INOS) activity. Increased synthesis of NO and superoxide anion radicals lead to increased concentrations of peroxy-nitrite and causes further damage. **Sener *et al*., (2015)** found that administration of formaldehyde into the rats resulted in an impaired antioxidant defense in the renal tissues, as shown by a significant reduction in the activity of antioxidant enzymes such as SOD and CAT in the formaldehyde group as compared to normal controls.

These outcomes are in consistent with those noted by **Sepehri *et al*., (2011)** who discovered that mice fed with maize silk extract had greater levels of SOD activity in their kidneys and attributed these results to the antioxidant and free radical-scavenging properties of corn silk, which includes phenolic compounds. Presented results are in the line with results **Al-Snafi, (2015)** who showed a protective effect of asparagus on nephrotoxicity in rats compared with the positive control, the content of serum malondialdehyde (MDA) were lower and the content of superoxide dismutase (SOD)

was higher in asparagus treated group. This might be accomplished by reducing the production of free radicals and increasing the activity of free radical scavengers.

Shi *et al.*, (2012) provided evidence that formaldehyde caused structural alterations in glomeruli and proximal convoluted tubules, which were more severely impacted than the distal ones. The findings are corroborated by their findings. This was explained by the fact that after the poisonous chemical has been filtered by the glomeruli, it initially contacts the proximal convoluted tubules. The present study's outcomes are in line with those of **Treesh *et al.* (2014)**, who discovered that the kidney tissues from the FA-injected group exhibited dilation in Bowman's capsule, congestion in the glomeruli and between the renal tubules, as well as vacuolation in the lining epithelium's cytoplasm of the proximal convoluted tubules with loss of their brush border. According to **Sepehri *et al.*, (2011)**, rats treated with corn silk shown indications of tube regeneration and protection from gentamicin-induced interstitial nephritis. Additionally, according to **Poormoosavi *et al*., (2018)**, the majority of the identified abnormalities in renal morphology were ameliorated in rats treated with bisphenol A after receiving asparagus officinalis extract. This was shown by little glomerular congestion, cell edema with largely intact renal tubules, and acute tubular necrosis levels that did not significantly differ from the control group owing to the decreased lipid peroxidation and enhanced antioxidant capacity. The flavonoids and polyphenols' exitance in *Asparagus Officinalis* extract may be responsible for its antioxidant qualities.

CONCLUSION

Biochemical and histopathological findings demonstrate that formaldehyde has harmful adverse effects on experimental animals. The findings showed that the tissues and functions of the kidneys were improved by employing high doses of aqueous extracts of corn silk and asparagus.

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Table (1): Protective effect of aqueous extracts of Corn silk and Asparagus on feed intake (FI), body weight gain (BWG %) and feed efficiency ratio (FER) in rats with renal toxicity **(**mean ± SD)

Parameters / Groups	FI (g) for 28 days	BWG gm (%) preceading period	FER
–ve **Control (G1)**	604.33±2.16^{a}	44.55±2.84^{a}	0.080±.006^{a}
+ve **Control (G2)**	412.50±1.87^{e}	20.72±2.92^{e}	0.063±.005^{d}
Corn silk 200 mg/ kg BW(G3)	531.70±2.53^{d}	32.38±2.36^{cd}	0 .070 ±.006^{c}
Corn Silk 400 mg /kg BW (G4)	571.36±1.97^{b}	41.17±2.04^{b}	0.075±.008^{b}
Asparagus 200 mg /kg BW (G5)	532.0±3.03^{d}	29.78±1.97^{d}	0.068±.007^{c}
Asparagus 400 mg /kg BW (G6)	550.33±7.11^{c}	35.09±3.39^{c}	0.072 ±.008^{bc}

Means in the same column with completely different letters are significantly different at p<0.05.

Table (2): Protective effect of aqueous extracts of Corn silk and Asparagus on relative kidney weight in rats with renal toxicity **(**mean ± SD)

Parameters / Groups	Relative kidney weight gm %
-ve Control (G1)	1.88±0.023^{a}
+ve Control (G2)	1.00±0.015^{d}
Corn silk 200 mg /kg BW (G3)	1.77±0.015^{c}
Corn Silk 400 mg(G4)	1.82±0.015^{b}
Asparagus 200 mg/ kg BW (G5)	1.75±0.029^{c}
Asparagus 400 mg /kg BW (G6)	1.80±0.015^{b}

Means in the same column with completely different letters are significantly different at p<0.05.

Table (3): Protective effect of aqueous extracts of Corn silk and Asparagus on kidney functions in rats with renal toxicity (mean ± SD)

Parameters / Groups	Creatinine (mg/dl)	Urea (mg/dl)	Uric acid (mg/dl)	Creatinine Clearance (ml/min)
–ve Control(G1)	0.54±0.05^{f}	22.53±3.56^{f}	1.75±0.14^{e}	1.31±0.097^{a}
+ve Control(G2)	1.31±0.13^{a}	97.30±1.46^{a}	3.35±0.17^{a}	0.350±0.035^{e}
Corn silk 200 mg/kg BW(G3)	0.84±0.05^{c}	51.51±3.22^{c}	2.55±0.14^{c}	0.79±0.098^{c}
Corn Silk 400 mg/kg BW(G4)	0.65±0.05^{e}	29.41±4.07^{e}	2.00±0.12^{d}	1.10±0.108^{b}
Asparagus 200 mg/kg BW(G5)	0.94±0.04^{b}	61.13±3.88^{b}	2.77±0.12^{b}	0.67±0.092^{d}
Asparagus 400 mg/kg BW(G6)	0.74±0.04^{d}	40.42±3.97^{d}	2.03±0.19^{d}	1.00±0.097^{b}

Means in the same column with completely different letters are significantly different at p<0.05.

Table (4): Protective effect of aqueous extracts of Corn silk and Asparagus on serum electrolytes in rats with renal toxicity (mean ± SD**)**

Parameters / Groups	Sodium (Na^{+}) mEq/L	potassium (K^{+}) mEq/L	Calcium Ca^{++}) mg/dl	Magnesium (Mg^{++}) mg/dl
–ve Control (G1)	142.85±1.30^{e}	4.61±0.15^{e}	9.83±0.17^{a}	3.03±0.10^{a}
+ve Control (G2)	160.64±3.69^{a}	5.97±0.14^{a}	7.78±0.24^{e}	2.51±0.07^{d}
Corn silk 200 mg/kg BW (G3)	154.09±1.17^{b}	5.32±0.09^{c}	8.63±0.24^{c}	2.68±0.09^{c}
Corn Silk 400 mg/kg BW (G4)	147.26±1.84^{d}	5.01±0.10^{d}	9.50±0.10^{b}	2.86±0.04^{b}
Asparagus 200 mg/kg BW (G5)	153.99±1.20^{b}	5.55±0.16^{b}	8.29±0.16^{d}	2.65±0.05^{c}
Asparagus 400 mg/kg BW (G6)	150.62±1.41^{c}	5.42±0.16^{bc}	9.33±0.16^{b}	2.77±0.08^{b}

Means in the same column with completely different letters are significantly different at p<0.05.

Table (5): Protective effect of aqueous extracts of Corn silk and Asparagus on blood glucose in rats with renal toxicity (mean ± SD)

Parameters / Groups	Blood Glucose (mg/dl)
–ve Control (G1)	77.75±3.68^{e}
+ve Control (G2)	137.00±2.28^{a}
Corn silk 200 mg/ kg BW(G3)	90.00±3.68^{c}
Corn Silk 400 mg/ kg BW (G4)	83.41±2.90^{d}
Asparagus 200 mg/ kg BW (G5)	100.00±3.68^{b}
Asparagus 400 mg/ kg BW (G6)	93.66±2.50^{c}

Means in the same column with completely different letters are significantly different at p<0.05.

Table (6): Protective effect of aqueous extracts of Corn silk and Asparagus on Liver functions in rats with renal toxicity (mean ± SD)

Parameters / Groups	ALT**(I/U)**	AST**(I/U)**	ALP**(I/U)**
–ve Control (G1)	25.08±3.55^{e}	97.37±2.44^{f}	268.33±3.20^{e}
+ve Control (G2)	55.08±3.26^{a}	207.95±2.88^{a}	314.91±3.72^{a}
Corn silk 200 mg/ kg BW(G3)	46.16±2.69^{b}	150.04±3.68^{c}	292.91±3.20^{b}
Corn Silk 400 mg/ kg BW (G4)	29.16±3.35^{d}	106.66±3.98^{e}	272.66±2.80^{d}
Asparagus 200 mg/kg BW (G5)	49.08±1.42^{b}	171.16±1.43^{b}	294.00±2.82^{b}
Asparagus 400 mg/kg BW (G6)	36.08±2.69^{c}	130.20±3.70^{d}	281.91±3.04^{c}

Means in the same column with completely different letters are significantly different at p<0.05.

Table (7): Protective effect of aqueous extracts of Corn silk and Asparagus on total protein, albumin and globulin in rats with renal toxicity (mean ± SD)

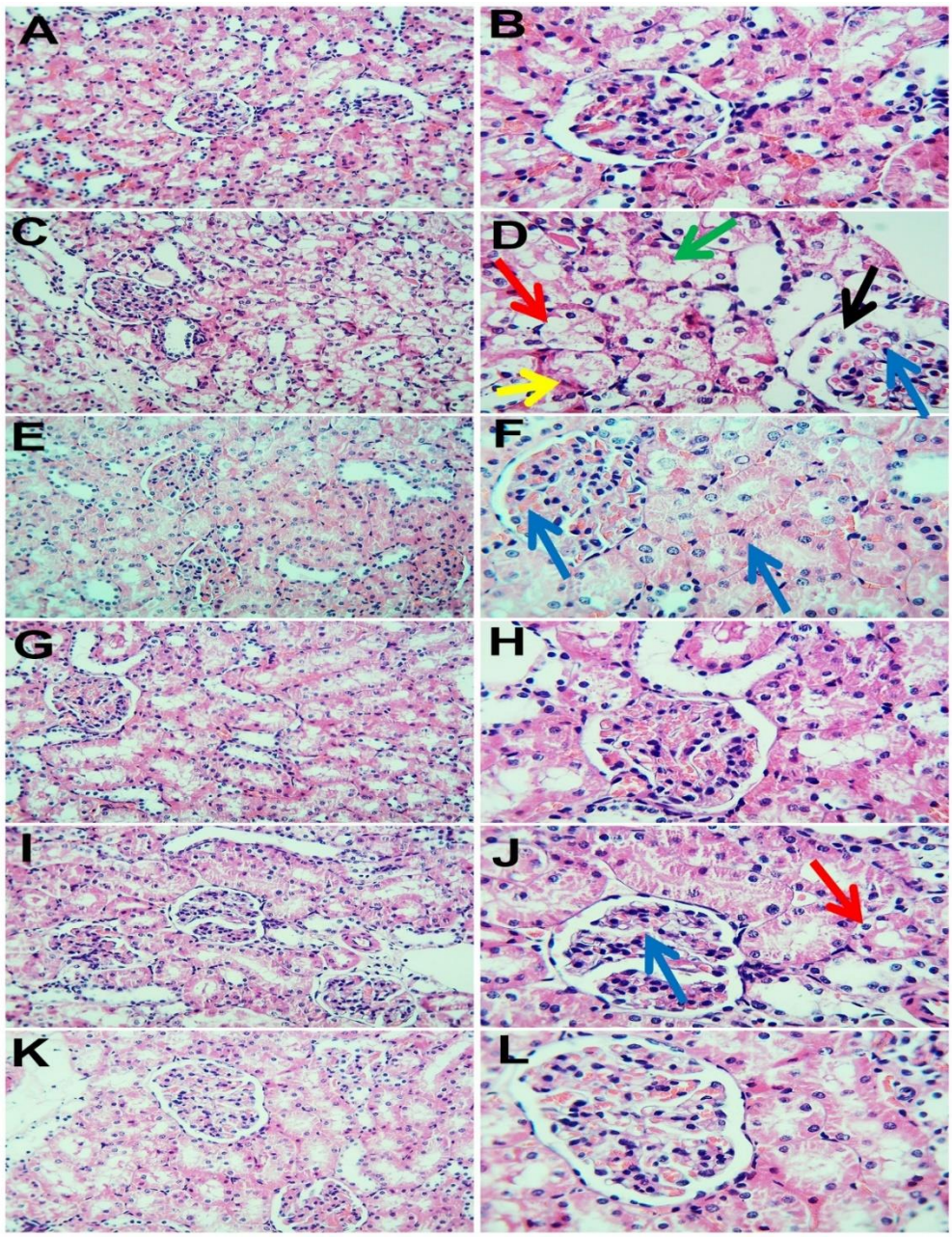
Parameters / Groups	T. Protein (g/dl)	Albumin (g/dl)	Globulin(g/dl)
–ve Control (G1)	8.30±1.48^{a}	5.12±1.49^{a}	3.18±1.00^{a}
+ve Control (G2)	4.25±0.82^{c}	2.90±0.041^{d}	1.35±0.050^{b}
Corn silk 200 mg/kg BW (G3)	6.25±2.27^{b}	3.76±0.045b^{bc}	2.49±1.00^{a}
Corn Silk 400 mg/kg BW (G4)	7.40±1.34^{ab}	4.50±0.041^{ab}	2.90±0.000^{a}
Asparagus 200 mg/kg BW (G5)	5.80±0.83^{bc}	3.02±0.008^{cd}	2.78±0.020^{a}
Asparagus 400 mg/kg BW (G6)	6.75±0.82^{ab}	3.89±0.059^{b}	2.86±0.030^{a}

Means in the same column with completely different letters are significantly different at p<0.05.

Table (8): Protective effect of aqueous extracts of Corn silk and Asparagus on serum tumor necrosis factor –α and CAT, SOD, MDA and NO in kidney tissues of rats with renal toxicity (mean ± SD)

Parameters / Groups	Serum TNF-α (pg/ml)	CAT (U/g.t)	SOD (U/g.t)	MDA (nmol/g.t)	NO (µmol/g.t)
-ve Control (G1)	21.60±1.80^{f}	2.94±0.09^{a}	148.40±2.0^{a}	9.99±1.62^{e}	2.26±0.14^{d}
+ve Control (G2)	90.15±4.05^{a}	1.15±0.21^{e}	61.21±2.0^{f}	23.35±0.74^{a}	6.07±0.31^{a}
Corn silk 200 mg/ kg BW(G3)	51.15±2.15^{c}	2.09±0.19^{c}	112.25±3.0^{d}	16.82±0.62^{c}	4.11±0.20^{b}
Corn Silk 400 mg/kg BW (G4)	28.65±2.95^{e}	2.48±0.17^{b}	133.09±3.0^{b}	12.35±1.39^{d}	3.06±0.20^{c}
Asparagus 200 mg /kg BW (G5)	59.45±3.05 b	1.68±0.04^{d}	85.76±3.0^{e}	19.60±0.21^{b}	4.38±0.26^{b}
Asparagus 400 mg /kg BW (G6)	36.30±3.76 d	2.32±0.20^{bc}	123.80±3.0^{c}	13.35±1.17^{d}	3.22±0.21^{c}

Means in the same column with completely different letters are significantly different at p<0.05.



Microscopic images of hematoxylin and eosin (H& Ex 400) stained kidney sections showing (A) Normal (-ve) Control group. (B) formaldehyde (+ve) Control group. (C) formaldehyde + Corn silk (200 mg /kg) group. (D) formaldehyde +Corn silk (400 mg/ kg BW) group. (E) formaldehyde+ Asparagus (200 mg/kg) group (F) formaldehyde+ Asparagus (400 mg/kg BW)

التأثيرات الوقائية المحتملة للمستخلصات المائية لبعض الاعشاب على التسمم الكلوي المحدث بالفورمالدهيد في جرذان التجارب

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أجريت الدراسة الحالية لمعرفة التأثير الوقائي للمستخلصات المائية لكلا من حريرة الذرة والهليون ضد السمية الكلوية التي يسببها الفورمالدهيد في جرذان التجارب . تم استخدام ستة وثلاثون من ذكور الجرذان تتراوح أوزانهم بين (150 ± 10 جم) قسمت إلي مجموعتين رئيسيتين. المجموعة الأولي (6جرذان) تغذت علي الغذاء القياسي كمجموعة ضابطه سالبه المجموعة الثانية (30 جرذ) تم حقنها بالفورمالدهيد في الغشاء البروتوني بمقدار 10 مجم / كجم من وزن الجسم / يوم من اليوم الرابع عشر إلي اليوم الثامن والعشرون وتم تقسيم هذه المجموعة إلي خمس مجموعات فرعية . مجموعه (1) تتغذى على الغذاء القياسي كمجموعة ضابطة موجبة . مجموعة (3,2) تغذت علي الغذاء القياسي بالإضافة إلي جرعات من المستخلصات المائية لحريرة الذرة (200 و 400 ملجم / كجم من وزن الجسم) عن طريق الفم لمدة 28 يوما .مجموعة (5,4) تغذت علي الغذاء القياسي بالإضافة إلي جرعات من المستخلصات المائية للهليون (200 و 400 ملجم / كجم من وزن الجسم) عن طريق الفم لمدة 28 يوما . في نهاية التجربة تم حساب المأخوذ الغذائي, الزيادة المكتسبة في الوزن, معدل كفاءة الغذاء و الوزن النسبي للكلي .كما تم تقدير بعض النماذج البيوكيميائية في السيرم و مضادات الأكسدة والعوامل المؤكسدة في أنسجه الكلي كما أجري الفحص الهيستوباثولوجي لأنسجة الكلى . أظهرت النتائج أن المستخلصات المائية لحريرة الذرة والهليون أدت إلى تحسين في التقييم البيولوجي ووظائف الكلى ووظائف الكبد و إلكتروليت المصل والإنزيمات المضادة للأكسدة و الفحص الهستوباثولوجى لأنسجة الكلي مقارنة بالمجموعة الضابطة الموجبة لذلك يمكن أن نستنتج أن تناول المستخلصات المائية لكلا من حريرة الذرة والهليون يمكن أن تقلل من تأثير الفورمالدهيد الضارة على الكلى.

الكلمات المفتاحية : *حريرة الذرة ، الهليون , الفورمالدهيد ، وظائف الكلى ,الأنزيمات المضادة للأكسدة .*