Protective effect of Corn silk (*Zea mays L.*) on kidney and liver functions of rats

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ABSTRACT

Corn silk has traditionally been seen as a waste material, but in numerous areas around the world, it is used as a traditional medicine. The main objective of this study was to study the effects of corn silk (Zea mays L.) powder, ethanolic extract, and corn silk tea on protecting rats from kidney failure and liver injury and their action on pathogenic bacteria. Corn silk ethanolic extract had the highest total phenolic content and total flavonoid content. Seventeen kinds of phenolic were detected; Ferulic acid has the highest amount of phenolic content. The corn silk extracts showed excellent phytochemical and antioxidant activity. Additionally, they have strong antimicrobial properties. The biological experiment was carried out on thirty male rats weighing (200 ± 5 g) for six weeks and divided into five groups, one of which was a negative control (Basel diet) 2, 3, 4, and 5 groups were given gentamicin by injection to induce liver and kidney toxicity, (group2) was a Positive control and the 3, 4and5 groups were treated with different corn silk treatments. The result demonstrated that corn silk and its extract enhanced antioxidant enzymes using superoxide dismutase (SOD), and Total Antioxidant Capacity (TAC), Lipid peroxidation was evaluated as Malondialdehyde (MDA), liver functions, kidney functions, and histopathology of the kidneys when compared with the positive group. Finally, this study found that corn silk has antimicrobial activity against pathogenic microorganisms as well as renoprotective and hepatoprotective effects against gentamycin-induced hepato-nephrotoxicity.

Keywords: *corn silk - antimicrobial – gentamycin – kidney function- liver function.*

INTRODUCTION

Corn silk has long been regarded as a waste product, yet it is increasing in popularity in Asia and Africa. Corn silk extract, often regarded as a waste product, has been demonstrated to have therapeutic value in the treatment of diabetes, hyperlipidemia, cancer, cardiovascular disease, microbiological infections, as well as other chronic and age-related diseases. As a result, cornsilk could be beneficial to human health (**Sanusi *et al*., 2020).** Corn silk is made from the stigmas of female corn petals. Corn silk threads are silky, 10–20 cm long, pale green or yellow-brown in color, and have no known toxicity **(El-Seedy *et al*., 2022)**

After corn harvesting, the isolated and identified chemicals from corn silk were thrown as waste, including phenolic compounds, sterols, flavonoids, alkaloids, polysaccharides, organic acids, volatile oils, trace elements, and multivitamins. Additionally, it wastes resources and destroys the environment. (**Shuangqi Tian *et al*., 2021**). Corn Silk is a beneficial herb that promotes and is helpful to health, contains minerals such as magnesium, calcium, sodium and magnesium salts, potassium, and many bioactive substances (flavonoids, vitamins, phenolic compounds, alkaloids, steroids, carbohydrates, and proteins) (**Ayesha *et al*., 2022).**

The corn silk material is highly useful for usage as a natural source of polyphenols, which are used to create goods with added value, functionnality, and nutraceuticals. Corn silk has a high level of nutritious bioactive compounds like polyphenols, flavonoids, and ascorbate, as well as high antioxidant activity. (**Jyoti Singh *et al*., 2022).** A popular traditional Chinese medication in China is corn silk, which is used to treat kidney-related diseases such as cystitis, gout, rheumatism, rheumatoid arthritis, edema, and antimicrobial effects **(Amreen *et al*., 2012; Chen *et al*., 2013).** Corn silk has significant antioxidant activities *in vitro* and *in vivo*, indicating it could be used in both food and medicine as an

antioxidant (**Liang Zhang *et al*., 2021).**

An aminoglycoside antibiotic called gentamicin is used to treat gram-negative bacterial infections. **Fitri *et al*., (2022)** According to the study, ethanolic extract from corn silk has a bioactive source such as tannins, steroids, terpenoids, flavo-noids, and phenolic compounds like vanillic acid, ferulic acid, anthocyanins, quercetin, p-coumaric acid that inhibits the growth of bacteria such as *P. acnes*, *S. epidermidis*, and *S. aureus*. It can cause acute renal damage in 10% to 30% of patients **(Sepehri *et al*., 2011).** The use of gentamicin (GM) is among the leading causes of nephrotoxicity which is used to develop Acute Kidney Injury (AKI) **(Babaeenezhad *et al*., 2021).** Gentamicin has reduced clinical benefits due to its side effects. The gentamicin side effects include liver damage and the highest level of nephrotoxicity which are caused by increasing the production of reactive oxygen after the use of gentamicin in cells; causing toxic effects on tissue structure and function**. (Medic, 2019).**

The goals of this study were to examine the effects of corn silk extract on pathogenic microorganisms as well as various biochemical indicators in rat models of gentamicin-induced liver and kidney damage.

MATERIAL AND METHODS

Materials

Plant: Corn silk (CS) was obtained from corn fields in a small town near Giza, Egypt.

Chemicals: According to the manufacturer's instructions, kits were acquired from the Biodiagnostic Company (Dokki, Giza, Egypt) to measure the biochemical parameters.

Gentamicin (GM) was obtained from a pharmacy that was manufactured by Alexandria Company for Pharmaceutical Industries, Alexandria, Egypt.

Animals: The National Research Center's (NRC) Animal House provided a total of 30 adult male Wistar rats, each weighing 200±5g.

Tested microorganisms: The bacterial strains used *Pseduomones aeruginosa*

ATCC 27853, *E. Coli* ATCC25922, *Staphylococcus aureus* ATCC 25923, and *Salmonella typhimurium*, ATCC 20231. **Mold:** *Aspergillus flavous Link, and Aspergillus niger*, were isolated from various rotting sources (fruits, grains, vegetables) (**Rizk *et al.,* 2009), Yeast:** *Candida albicans* CAIM -22 was obtained from MIRCEN.

Methods

Preparation of plant extracts

Corn silk was purified by washing it with tap water to remove impurities. It was then air-dried, powdered, and kept in polyethylene bags in a refrigerator at 4°C for subsequent procedures. In this experiment used corn silk powder, ethanolic extract, and aqueous extract**.** A study on Corn silk tea extract was performed by **Sahib *et al.,* (2012).** The maceration method was used to create the ethanol extract of CS. After steeping 10 g of the plant powder in 100 ml of ethanol for three days, the mixture was filtered through muslin cloth, (Whatman No. 1) filter paper, and then concentrated in a rotary evaporator. The crude extract was weighted **Emmanuel *et al.,* (2016).** It is used for the determination of total phenolic content, total flavonoids, (2,2-diphenyl-1-picrylhydrazyl) free radical scavenging action (DPPH) activity, antimicrobial activity, and biological experiments.

Analyses of the corn silk chemical composition

The **AOAC (2018)** procedures were used to determine the levels of moisture, protein, fat, crude fibers, and ash. Total carbohydrates were calculated by difference: 100 - (weight in grams [moisture +protein + fat + + ash + fiber]**.**

Assessment of Minerals in cornsilk

Determination of zinc (Zn), manganese (Mn), iron (Fe), Copper (Cu), magnesium (Mg), Sodium (Na), Potassium (k), and calcium (Ca) determined using a PyeUnicum SP1900 Atomic Absorption Spectroscopy instrument (Perkin Elmer model 4100ZL) were carried out as described by **AOAO, (2018).**

Assessment of Total phenolic content (TPC), Total flavonoid content (TFC), and anti-oxidants by DPPH.

Nithiyanantham *et al*., (2012) used the Folin-Ciocalteu technique to determine the Total phenolic contents of CS powder, CS tea (water extract), and CS ethanolic extract. The (Aluminum chloride) $AlCl_3$ technique was used to measure the total flavonoid content as previously reported by **Liao *et al*., (2011)**. (**2,2-Diphenyl-1-Picryly-brazil**) the DPPH radical scavenging assay was carried out by **Wang *et al*., (2007).**

Assessment of phenolic compound and Fractionation of Vitamins A, E, and C by High-Performance Liquid Chromatography (HPLC). Determination of phenolic compound according to **Zhang *et al*., (2020)** using 4.6 x150 mm and 5 µm chromatographic columns at 30 °C with a controlled flow rate of 0.8 mL min^{-1} and adjusted wave-lengths of 360 nm on an HPLC system (Agilent 1260, Agilent, USA). The analysis was performed by HPLC for vitamins and equipped with a variable wavelength detector (vitamin A) at 330 nm, (vitamin E) at 295 nm **(Plozza *et al*., 2012)** but the fractionation and identification of ascorbic acid (Vitamin C) at 226 nm by **(Romeu-Nadal *et al*., 2006).**

Assessment of the anti-microbial activity by Well diffusion

The antimicrobial activity was detected in dry corn silk in ethanol (80%) and water extracts**.** For bacteria used nutrient agar media and potato dextrose agar for fungi and yeast. 0.1 ml of the inoculums of each tested organism was transplanted into the plates. Using a loop, the inoculums were distributed uniformly throughout the plates. A standard cork borer was used to cut uniform wells on the surface of the NA and PDA plates. CS extracts were added to the well in concentrations of 200 and 400 (mg/ml). The plates were incubated for 24 hours at 37°C for bacteria, 28-30 °C for fungi and yeast then measured the inhibition zone to the nearest (mm) (**Olaleye, 2007).**

Animals and Experimental Design

Before starting the experiment, the animals were given water and the Basal

laboratory diet for 7 days to adapt. The basal diet was prepared according to the recommended dietary allowances for rats adjusted by **Reeves *et al.*, (1993)**. Thirty male rats were used in the study, weighing 200 ± 5 g for 6 weeks. Five groups of experimental rats were used, 6 rats in each, and then divided into the following subgroups in **Table (1)**.

The body weight gain was recorded. The following formula was used to estimate **Body weight gain percentage (BWG %):** (Final weight (g) - initial weight (g)/ initial weight (g)) x100.

At the end of the experiment, the rats fasted for 12 hr; blood samples were collected into plain tubes without anticoagulant and allowed to clot. Blood samples were centrifuged at 3000 rpm for 10 min at 4°C, to obtain clear serum that was frozen at -18^{o}C until analyses. Both kidneys were removed; the first was preserved at 18 °C for additional research into the antioxidant activities of the kidneys, such as Superoxide Dismutase (SOD) and Glutathione Peroxidase (GPx). For histology, the other was preserved in 10% formalin.

Assessment of biochemical analysis:

By measuring the formation of malondialdehyde (MDA), lipid peroxidation was evaluated as explained by **Ohkawa *et al.*, (1979),** (SOD) activity was detected using the technique of **Nishikimi *et al.*, (1972),** and **(**TAC) according to **Cao *et al.*, (1993).** (GPx) described by **Ellman (1959)**.

Serum creatinine was determined at 495 nm as given by **Fossati *et al.*, (1980).** Serum urea nitrogen was measured at 550 nm by **Fawcett and Soctt, (1960).** According to **Carawy, (1955)** Uric acid was detected. The determination of liver tissue when livers were instantly soaked in 50 to 100 ml of ice-cold normal saline solution total lipids **Folch *et al.*, *(*1957),** triglycerides, **Fossati and Prencipe (1982)**, Cholesterol **Richmond**, **(1973)** and glycol-gen according to **Rerup and Lundquist, (1967).** According to **Tietz, (1976)** was used to determine the serum Alanine amino transferees (ALT). The

determination of aspartate amino transferees (AST) was described by **Henry, (1974); Young et al., (1975)**. Alkaline phosphatase (ALP) conce-ntration was measured using the technique of **Kind and King (1954).**

Assessment of Histopathology

The animals were slaughtered after being sedated with ether and dissected immediately to remove the kidney. Organs are immersed in paraffin and fixed in 10% formaldehyde. Hematoxylin and eosin (H and E) were used to stain sections of 5 mm thickness, which were then inspected under a light microscope for pathological alterations in accordance with the rules of **Hirsch *et al*., (1997)**.

Statistical analysis

All data obtained from the study had been submitted for statistical analysis by SPSS computer soft war by analyzing divergence ANOVA and the related test LSD using SPSS ver. 11 according to **Abo-Allam, (2003).**

RESULT AND DISCUSSION

In Table (2) the analysis of the chemical composition of CS was estimated and recorded as Moisture 4.33±0.0717 the low moisture content extends its shelf life and makes it simple to use, Protein is13.0±1.0031, lipids are1.13±0.0815, crude fiber is 21.01±1.0210, ash is 6.43±0.0512 and carbohydrates are 54.11±0.6341% in dry corn silk, carbohydrates have the highest percentage content compared with other nutrients. Minerals content such as minor elements **(**Zn 2.066 ± 0.0577 µg/g, Mn, 1.65±0.0371 Fe 1.93 ± 0.04567 µg/g and Cu 45.6±0.1346 µg/g. Macro elements Ca 877.30±0.3340 µg/g, Mg 711.00±1.0112 µg/g, Na 216.44±0.1210 µg/g and K 30262±1.0208 µg/g. **Abdul Rahman and Rosli (2013)** reported that the CS rich in minerals such as Ca 1087.08 ± 105.51 µg/g, Mg1219.17 ± 143.07 µg/g, K 26281.67 ± 1379.7 µg/g, and Na 190.67 ± 22.61 µg/g. The proximate composition of corn silk powder was determined previously by **(El Kewawy**, **2018)** who found that fiber, ash, fat, Protein, and carbohydrates contents were 20.1, 6.13, 1.91, 13.57 and51.35%, respectively in dry weight corn silk. The moisture

content was 7.04%, which also illustrated some mineral content in corn silk (CS). The values of zinc (Zn), iron (Fe), copper (Cu), magnesium (Mg), and calcium (Ca) were 2.77 (µg/g), 1.96, 1.86, 47.3, 0.65, and 8.16 (mg/100 g) respectively **Nuntaporn Aukkanit *et al*., (2015)** found that carbohydrate, protein, crude fiber, moisture, ash, and fat contents were 51.37, 17.94, 16.11, 9.06, 4.60, and 0.91g/100g, respectively. K and Na contents of mature corn silk were 35671.67, and 266.67 l g/g, respectively.

The findings in Table (3) detected total phenols and flavonoids, which act as antioxidants in (CS) ethanol extract, (CS) tea (water extract), and (CS) powder 119.01 ± 0.500, 105.66 ± 0.571 and 80.40 ± 0.100 mg GAE /g (GAE gallic acid equivalents), respectively. The total flavonoids in CS ethanol extract, CS tea (water extract), and corn silk powder were 86.3±0.1012, 68.300±0.1035 and57.266±0.1153 mg RE/g respectively **(**RE rutin equivalents). The antioxidant activity observed in corn silk ethanol extract, corn silk tea (water extract), and corn silk powder was determined by DPPH Radical-Scavenging activity to be 85.301±0.1210, 82.511±0.1440 and 77.300 ± 0.1023 %, respectively. According to studies, the ethanol extract of corn silk has higher concentrations of flavonoids and phenolic compounds. These data were in agreement with (**El Kewawy, 2018)** the total phenolic and total flavonoid contents in CS varied from 80.8 to 117.1 mg GAE/g and 30.1 to 88.8 mg RE/g respectively. **Xizhu *et al*., 2021 and Sarepoua *et* al., 2013** showed that the quantity of phenol and flavonoid in corn silk changes to different growth conditions, or different extraction techniques used**.** Seventeen kinds of phenolic content in CS extract was detected at 360 nm by HPLC, and the results are shown in Table (4) the largest amount of phenolic content in corn silk is ferulic acid 6118.98 µg/g followed by Gallic acid 4410.23 µg/g , Ellagic 3524.31 µg/g, Quercetin 3217.03 µg/g, *p*- Coumaric acid 2776.21 µg/g and Chlorogenic 1010.32 µg/g while the Benzoic acid 28.67

µg/g and Syringic acid 64.73 µg/g had the lowest amounts detected. **Xiaodan Hu *et al*., (2022)** detected eight kinds of phenolic components by HPLC of which ferulic acid was the main component and Gallic acid. The main phenolics in sweet corn were gallic acid, chlorogenic acid, *p*-coumaric acid, and ferulic acid, and quercetin was only detected in corn silk compared with other parts of corn**. Fahmy (2020)** indicated that corn silk contained mild amounts of myricetin acid, benzoic acid, Salicylic acid, Neringein, and Kampherol, respectively. Corn silk also contains vitamins such as vitamin E (0.334 ± 0.0577 mg /100g), Vitamin A (278±0.038 I U), and (Vitamin C) 11.01± 0. 0652 mg /100g, according to the findings. (El Kewawy, 2018) reported that the Vitamin C (9.72 mg/100g), vitamin E (0.215 mg/100g) and vitamin A (266 I U equal to 7.98 mg/100g).

Investigating anti-microbial effects against four types of bacteria, two fungi and one yeast by good diffusion are shown in **Table (5)** *Pseudomonas aeruginosa* and *Staphylococcus aureus* pathogens causing the most opportunistic infections commonly associated with respiratory diseases, urinary tract infections, and gastrointestinal infections, *Escherichia coli* has been identified among the array of causative agents responsible for acute diarrhea and other urinary tract infections **(Akoachere *et al* ., 2015; Darwish *et al*., 2010)**. According to the data, the extract has reasonable effects against pathogenic gram-positive and gram-negative bacteria, fungi, and yeast. So, the plant extract has the ability to be used as a treatment for diseases caused by these organisms. The zone inhibition ranged between 22 and 13 mm in the ethanol extract, but 20 to 11 mm in the water extract. The largest inhibition zones were found in both the ethanol and water extracts for *Staphylococcus aureus* 22 mm, and 20 mm, respectively. The lowest inhibition zones detected in *Candida albicans* were 13 mm in ethanol, and 11mm in the water extract.

The current result is similar to **Emmanuel *et al*.,**

(2016) who showed antimicrobial activity toward *Staphylococcus aureus, Pseudomonas aeruginosa, Klebsciella pneumonia, Escherichia coli,* and *Salmonella thypi* and the most effective against *Staphylococcus aureus*. **Al-Sorchee *et al.*, (2016)** indicate the antibacterial activity of ethanol and water extracts of *Zea mays L* was investigated on *E. coli* and *Staph. albus, Stap. capitis, Staph epidermidi, Staph. aureus, Pseudo luteola, Pseudo. Aeruginosa, P. mirabilis, Morganella. Morganii, K. Pneumonia, K. oxytoca, Micrococcus,* and *Citrobacter freundii,* there is more antibacterial activity in alcoholic extracts than in aqueous extracts. **Shuangqi Tian *et al.*, (2021)** reported that antimicrobial activities of different solvent extracts of CS can protect the human body from different disease conditions happened by pathogenic organisms due to the presence of Phytochemical compounds. Corn silk extract exhibits antibacterial efficacy against different pathogens including *E. coli, Klebsiella pneumonia, Pseudomonas aeruginosa, Salmonella typhi,* and *Staphylococcus aureus* so it has reasonable action against both gram-positive and gram-negative bacteria due to great phytochemical and antioxidant activity **(Rajeshwari and Sivapriya, 2021).**

According to **Table (6),** the positive control group had a significantly reduce body weight gain than the other treatments and the negative control group. The groups of corn silk tea, corn silk ethanol extract, and corn silk powder had significant increases in BWG 5.29, 9.3, and 5.67% respectively, but the positive group had a significantly higher increase in BWG 1.102 %. These findings are consistent with those of **El-Seedy *et al.*, (2022),** who found that body weight gain was significantly reduced in the positive control group in comparison to rats fed corn silk and the negative control group, which had a significant increase in BWG%. Also, **Ho *et al.*, (2017)** reported that the rats with kidney stones disease diets using corn silk at different levels increased body weight gain compared with a positive control group**. Kim *et al.*, (2012)** showed that oral

administration of Corn Silk produced significantly increased body weight gain and feed intake.

SOD, MDA, TAC, and GPX activities were used to measure the antioxidant activity in vivo. **Table (7)** shows a significant increase in MDA levels but a significant decrease in TAC, SOD, and GPx when compared to the negative control, as well as a significant reduction in MDA when compared to the positive control. Moreover, the best value of SOD, MDA, TAC, and GPx showed in Corn silk extract then corn silk tea, and corn silk powder as the last one. The results were due to the nutritional compositions and the antioxidant ability of the corn silk (CS)**. Hu and Deng, (2011)** described that corn silk significantly raises levels of antioxidant enzymes such as (SOD) Superoxide Dismutase and (CAT) Catalase Activity, volatile oxygen-containing chemicals, and the free radical scavenging ability of corn silk extracts that contain some polyphenols and flavonoids. **Maksimovic et *al., (*2005); El-Ghorab *et al.,* (2007**) evaluated the effect of the antioxidant and free-radical scavenger maize silk on the oxidative injury and renal injury caused by Gentamycin. SOD is thought to be a key defense line against the potentially cytotoxic O_2 free radicals that induce oxidative stress **Mallikarjuna *et al.,* (2008**). The results agree with **Fahmy, (2020)** who reported that antioxidant enzymes (SOD and CAT) were significantly improved in all examined groups that were fed on the experimental diets containing different levels of corn silk 5%, 7.5%, and 10% when compared with the positive control group (injection of CCL_4). However, serum MDA decreased significantly in the tested groups which were treated with 5%, 7.5%, and 10% cornsilk in comparison with the positive control group.

Table (8) displays the rat's serum levels of urea, creatinine, and uric acid after gentamicin injection indicating significantly increased ($P < 0.05$) urea, creatinine, and uric acid levels in the positive control group. The parameters of kidney function were

significantly decreased after feeding on corn silk powder, corn silk extract and Corn silk tea, both corn silk extract and corn silk tea had significantly lower ($P < 0.05$) levels when compared to the positive control. Urea nitrogen and creatinine levels were measured to assess renal toxicity with the increase in creatinine in the positive control group due to impaired kidney function caused by the toxicity**.** Corn silk contains diuretic compounds that aid in the reduction of inflammation and renal issues. When compared to the positive control rats those treated with corn silk had significantly lower blood creatinine and urea levels **Nessa *et al*., (2021).** Significant renal damage was caused by gentamicin 80 mg/kg BW for 7 days, as seen by the increase in BUN levels, decreased hypocellularity of glomeruli, modestly enlarged tubules, modest brush border loss, severe infiltration, the substantial tubular cast present and there is tubular degeneration (**Aldahmash *et al*., 2016). Xizhu Wang *et al*., (2021)** studied that the corn silk polysaccharide reduces renal injury and promotes uric acid excretion. When some dangerous compounds that damage the kidney cells are inhaled, consumed, or injected, it results in nephrotoxicity, which is characterized by a change in the functional composition of the kidneys. Up to 500 mg/kg of corn, silk is used to treat nephrotoxicity (**Orr and Bridges 2017).** A rat model was used to test the nephrotoxicity of a methanolic extract of corn silk, corn silk methanol extract has been shown to lower urea (35.15 ± 2.29) and creatinine (0.38 ±0.45) levels **Wans *et al*., (2021)**.

According to **Ayesha *et al*., (2022)**, corn silk extracts significantly reduced serum urea and serum creatinine levels. The current study demonstrates the therapeutic potential of Corn in rat models of ARI caused by Gentamicin.

In Table (9) triglyceride and glycogen levels in the liver were found to be considerably lower, while the cholesterol and total lipid contents were significantly higher in the positive control group than in

the negative control. The best extract for ameliorating liver biomarkers was corn silk extract followed by Corn silk tea and corn silk powder. The liver glycogen, cholesterol, total lipids, and triglyceride levels in the corn silk ethanol extract were comparable to the negative control group. **El Kewawy, (2018)** found that when compared to the positive control, the corn silk-treated rats showed a considerable improvement in the lipids of the liver, including glycogen, cholesterol, total lipid, and triglycerides. **Tuty and muchlisyam, (2018)** showed in this study the traditional treatment use of kidney stones and the diuretic properties of corn silk stew. By allowing calcium to react with carbonate, oxalate, phosphate, or uric to produce water-soluble potassium oxalate, potassium carbonate, potassium phosphate, or potassium urate molecules, potassium's high content can remove calcium salt from kidney stones

The Effect of Corn Silk Tea (Water Extract), Corn Silk Ethanol Extract, and Corn Silk Powder as Treatment Protection of Liver Enzymes (ALT, AST, and ALP) on Gentamycin-Injected Rats are shown in Table (10). However, the rats treated with water extract, corn silk ethanol extract, and corn silk powder demonstrated a significant decrease in serum AST, ALT, and ALP enzyme 95.33±0.510, 209.13±0.428 and 318.400 ± 0.1100 (μ/l) respectively as compared to the positive control group. The corn silk ethanol extract recorded the best results in ALT, AST, and ALP enzymes. **Nader *et al*., (2018); Fanoush *et al*., (2018)** reported that corn silk contains flavonoids, which have an antioxidant capacity which that protects hepatic tissues from damage, corn silk has a great effect on the improvement of liver function. **El-Seedy *et al*., (2022)** studied that corn silk improved serum glucose levels, liver functions, and kidney functions in rats these improvements were increased with the corn silk concentration increase. **Arba *et al*., (2020)** reported that corn silk has a great hepatoprotective effect due to its phytochemical contents which act as

antioxidant agents. Only 0.36g of fats was present in the corn silk, consequently, it can be utilized to treat hepatic disorders **(Bhuvaneshwari *et al*., 2017).** The improvement of liver and kidney parameters recommended by the consumption of corn silk extract whether aqueous or alcoholic with vitamin D may be attributed to the corn silk contents of antioxidant agents such as phenolic compounds, vitamins, and minerals **(El Kewawy, 2018). Arba *et al*., (2020)** reported that corn silk had a hepatoprotective effect in male Wistar rats, which decreased the level of Alkaline Phosphatase (ALP) to 18.74% and increased the level of liver Glutathione (GSH) to 7.210%. **Gohari and Mahdy, (2018)** study the effects of different concentrations of Arabic Gum (AG) and corn silk (CS) extracts against kidney and liver toxicity induced by a gentamicin dose 80 mg/kg for 8 days induce nephrotoxicity, which biochemically demonstrated a significant rise in blood urea, uric acid, and serum creatinine but liver enzymes, Total Bilirubin increased and total protein reduced. All extracts improved kidney function and liver enzymes in comparison with the control (+) group.

Microscopically, the histological structure of renal tissue in the kidneys of the negative group of rats was examined (Pho. 1), revealing a renal cortex with tubules (T) and glomeruli (G), as well as normal renal glomeruli and tubules. However, in the positive control, vacuolization of the epithelium lining renal tubules was observed in the kidneys of rats (Pho. 2). Parenchymal damage, tubule degeneration, cell necrosis, dilated blood vessels, and hemorrhage were all seen after gentamycin induction. Acute tubular necrosis is one of the signs of GM-induced renal damage. Meanwhile, in the treatment group, there was marked parenchymal damage and tubules with degeneration and cell necrosis, but kidney damage was lower than in the positive controls. The Corn Silk Tea (water extract) (**Pho. 3),** the Corn Silk Ethanol Extract **(Pho. 4),** and the Corn Silk Powder **(Pho. 5**) showed

an improvement in the histological morphology of the renal parenchyma, reduced the number of necrotic cells, and reduced areas of bleeding and inflammation. **Sepehri *et al*., (2011)** reported that rats treated with corn silk showed indications of tube regeneration and protection from gentamicin -induced interstitial nephritis. **Abdel Hamid *et al.*, (2022)** Indicated that the tissues and functions of the kidneys were improved by employing high doses of aqueous extracts of Corn silk and Asparagus after renal toxicity induced by formaldehyde. **Gohari and Mahdy (2018)** reported that the histopathological investigation of the liver and kidney in rats injected with gentamycin had the best improvement in liver enzymes obtained by using Arabic Gum Extract and Corn Silk Extract (CSE) had the best improvement in liver enzymes were obtained by using Arabic Gum Extract and Corn Silk Extract (CSE).

CONCLUSION

The study showed a high amount of protein content and a high number of phytonutrients present in corn silk, Phenolic compounds, flavonoids, and highly active antioxidants were found in the corn silk extract. Corn silk extract also has antimicrobial activity against pathogenic microorganisms. So it was used pharmaceutically**.** This was previously thought to be waste matter rich with useful compounds and this study demonstrated the reno-protective and hepato-protective effect of Corn silk against gentamycin-induced hepato-nephrotoxicity**.**

Data Availability: The corresponding author will provide the datasets created and/or analyzed during the current work upon reasonable request.

Ethics declarations:

Conflict of Interest: The authors declare no conflict of interest.

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Table 1: The Groups of Biological Experiment.

Group (1)	**Negative control was fed on a Basal diet.**
Group (2)	**Positive control (Gentamicin* + a Basal diet)**
Group (3)	**10 % corn silk Powder in a Basal diet+ rats injected with Gentamicin***
Group (4)	**Corn silk ethanol extract **400 mg/ml+ a Basal diet+ rats injected with Gentamicin*.**
Group (5)	**Corn silk tea 5ml/rat + a Basal diet + rats injected with Gentamicin***

*Gentamicin at a dose rate of 80 mg/kg body weight given intraperitoneally for 8 consecutive days to induce nephrotoxic **(Raju *et al*., 2011) for** groups, 3,4, and 5.
** The CS extract was created by dissolving 2000 mg of extract in 50 ml of distilled water, resulting in a concentration of 40 mg of extract per ml of solution **(Mehboob and Tahir,2015)**

Table (2): Analyses of the corn silk (%) powder's chemical composition and nutritional value.

Parameters	Corn silk (%)
Moisture	4.33±0.0717
Protein	13.0±1.0031
Lipids	1.13±0.0815
Crude fiber	21.01±1.0210
Ash	6.43±0.0512
Total Carbohydrate	54.11±0.6341
Minerals	
Zinc, (Zn) µg/g	2.066±0.0577
Manganese, (Mn) µg/g	1.65±0.0371
Iron, (Fe) ug/g	1.93±0.04567
Copper (Cu) ug/g	45.6±0.1346
Calcium, (Ca) µg/g	877.30±0.3340
Magnesium, (Mg) µg/g	711.00±1.0112
Sodium, (Na) µg/g	216.44±0.1210
Potassium, (K) µg/g	30262±1.0208

Data expressed as Means ± SD (n=3).

Table (3): Analyses of the Total phenol (mg GAE/g), Total flavonoid (mg RE/g) and antioxidant activity in corn silk.

Parameters	Corn silk powder	Corn silk tea (water extract)	Corn silk (Ethanol extract)
Total phenol (mg GAE/g)	80.40±0.100^{c}	105.66±0.571^{b}	**119.01±0.500^{a}**
Total flavonoid (mg RE/g**)**	57.266±0.1153^{c}	68.300±0.1035^{b}	**86.3±0.1012^{a}**
DPPH assay for radical scavenging activity (%)	77.300±0.1023^{c}	82.511±0.1440^{b}	**85.301±0.1210^{a}**

Data expressed as Means ± SD (n=3) *This means in the same row with completely different letters is significantly different at p<0.05.*

Table (4): Analysis of the phenolic content of corn silk and vitamins by HPLC.

Phenolic Compounds	Corn Silk (µg/g DW)
Ellagic	3524.31
Kampherol	384.09
Neringein	169.07
Salicylic acid	338.33
Gallic acid	4410.23
Myricetin acid	120.52
Rutin	105.04
Quercetin	3217.03
Cinnamic acid	3551
Benzoic acid	28.67
Caffeine	96.84
Caffeic acid	116.21
Ferulic acid	6118.98
Chlorogenic	1010.32
***p*- Coumaric acid**	2776.21
Vanillic acid	72.61
Syringic acid	64.73
Vitamins	
Vitamin E mg/100g	0.334±0.0577
Vitamin A IU	278±0.038
Vitamin C mg/100g	11.01±0. 0652

Data expressed as Means ± SD (n=3).

Table (5): Assessment of the antimicrobial activity of dried CS in ethanol (80%) and water extracts.

Pathogenic Microorganisms	Ethanol extract 400 (mg/ml)	water extract 400 (mg/ml)
	Inhibition zone (mm)	
Staphylococcus aureus	**22**	**20**
Escherichia coli	**18**	**16**
Salmonella typhi	**17**	**12**
Pseudomonas aeruginosa	**20**	**17**
Aspergillus Flaves	**14**	**12**
Aspergillus niger	**15**	**13**
Candida albicans	**13**	**11**

Table (6): Protective effects of corn silk tea (water extract), corn silk ethanol extract and corn silk powder on body weight gain in the experimental rats.

Treatments	Initial body weight (g)	Final weight (g)	Body weight gain %
Negative control	202.00 ± 1.105^{a}	223.0 ± 1.028^{a}	**10.39**
The weight after injection with Gentamycin			
Positive control	179.33 ± 0.531^{e}	181.20 ± 0.2005^{e}	**1.102**
Corn silk tea(water extract)	188.23 ± 0.571^{b}	198.200 ± 0.211^{c}	**5.29**
Corn silk ethanol extract	183.26 ± 0.923^{d}	200.366 ± 0.256^{b}	**9.3**
Corn silk powder	186.68 ± 2.50^{c}	197.266 ± 0.276^{d}	**5.67**

Results represent mean ± SD, the same letters in each column are not significant at P < 0.05.

Table (7): Protective effects of corn silk tea (water extract), corn silk ethanol extract and corn silk powder on SOD, MDA, TAC and GPx in the experimental rats.

Treatments	SOD (U/ml)	MDA (µmol/l)	TAC (mmol/l)	GPx (u/g)
Negative control	138.233±0.1598[a]	8.433±0.5624[e]	3.23±0.056[b]	**100.200±0.100[a]**
Positive control	59.266±0.2510[e]	23.800±0.1000[a]	1.266±0.057[d]	**72.433±0.050[e]**
Corn silk tea (water extract)	125.200±0.1004[c]	14.133±0.5774[b]	2.622±0.057[c]	**88.33±0.503[c]**
Corn silk ethanol extract	129.200±0.2101[b]	10.850±0.500[d]	3.133±0.100[b]	**96.24±0.412[b]**
Corn silk powder	123.500±0.156[d]	12.466±0.547[c]	3.400±0.057[a]	**82.63±0.513[d]**

Results represent mean ± SD, the same letters in each column are not significant at P < 0.05.
Superoxide Dismutase= (SOD) Malondialdehyde =(MDA)
Total Antioxidant Capacity =(TAC) Glutathione Peroxidase =(GPx)

Table (8): Protective effects of corn silk tea (water extract), corn silk ethanol extract and corn silk powder on kidney function of experimental rats.

Treatments	Urea (mg/dl)	Creatinine (mg/dl)	Uric Acid (mg/dl)
Negative control	26.900±0.1200[e]	0.560±0.0001[e]	**1.211±0.0214[e]**
Positive control	96.66±0.5230[a]	1.425±0.00251[a]	**3.233±0.0172[a]**
Corn silk tea (water extract)	37.201±0.1022[c]	0.720±0.0010[c]	**1.946±0.0354[c]**
corn silk ethanol extract	31.623±0.1420[d]	0.616±0.0057[d]	**1.407±0.044[d]**
corn silk powder	40.133±0.0871[b]	0.881±0.0020[b]	**2.033±0.0516[b]**

Results represent mean ± SD, the same letters in each column are not significant at P < 0.05.

Table (9): Protective effects of corn silk tea (water extract), corn silk ethanol extract and corn silk powder on lipid profile of experimental rats.

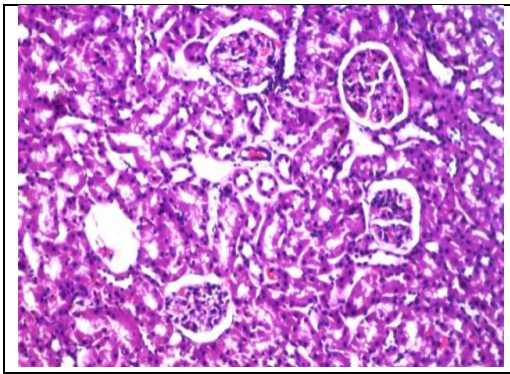
Treatments	Glycogen (mg/100g)	Cholesterol (mg/100g)	Total lipid (mg/100g)	Triglycerides (pg/g)
Negative control	8.133±0. 577^{a}	4.200±0.1013^{d}	39.100±0.101^{e}	**3.400±0.01^{a}**
Positive control	3.533±0.577^{e}	7.43±0.057^{a}	52.33±0.112^{a}	**2.200±0.103^{d}**
Corn silk tea (water extract)	6.233±0.0573^{c}	4.823±0.026^{c}	42.812±0.061^{c}	**2.933±0.051^{c}**
corn silk ethanol extract	6.89±0.042^{b}	4.233±0.02^{d}	40.3±0.087^{d}	**3.23±0.051^{b}**
corn silk powder	5.233±0.011^{d}	5.18±0.071^{b}	44.21±0.1055^{b}	**2.89±0.0142^{c}**

Results represent mean ± SD, the same letters in each column are not significant at P < 0.05.

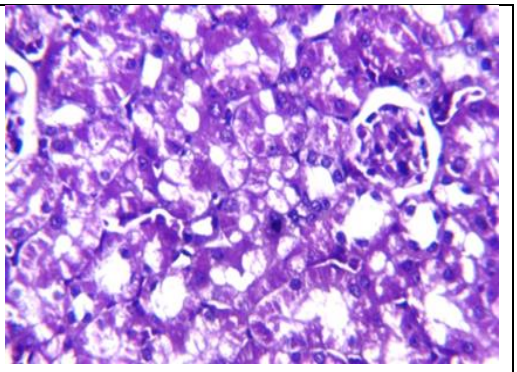
Table (10): Protective effects of corn silk tea (water extract), corn silk ethanol extract and corn silk powder on liver enzymes of experimental rats.

Treatments	ALT (U/L)	AST(U/L)	ALP (U/L)
Negative control	21.133±0. 056^{e}	93.467±0.040^{e}	**260.433±0.5301^{e}**
Positive control	95.33±0.510^{a}	209.13±0.428^{a}	**318.400±0.1100^{a}**
Corn silk tea (water extract)	31.266±0.1004^{c}	122.200±0.059^{c}	**270.733±0.218^{c}**
corn silk ethanol extract	25.800±0.1021^{d}	113.511±0.1000^{d}	**264.112±0.1100^{d}**
corn silk powder	65.655±0.505^{b}	148.200±0.1005^{b}	**278.340±0.1016^{b}**

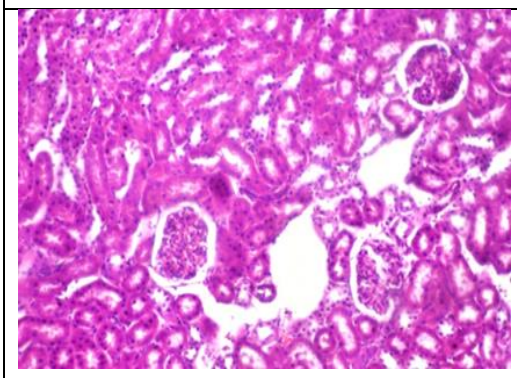
Results represent mean ± SD, the same letters in each column are not significant at P < < 0.05.



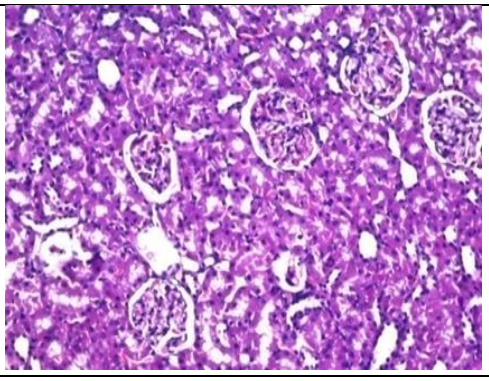
Pho. (1): group 1 showing the negative control histological structure



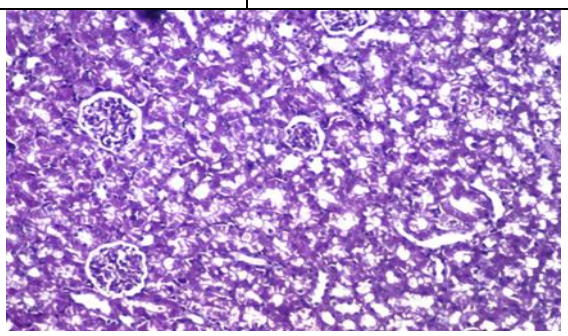
Pho. (2): group 2 showing the positive Control (GM group).



Pho. (3): group 3 showing the treated with Corn silk tea (water extract)



Pho. (4): group 4 showing the treated with Corn silk ethanol extract



Pho. (5): group 5 showing the treated with Corn silk powder
Microscopic images of hematoxylin and eosin (H& Ex 400) stained kidney sections

التأثير الوقائي لحرير الذرة (*Zea mays L.*) على وظائف الكلى والكبد لدى الجرذان

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الملخص العربى :

الهدف الرئيسي من هذه الدراسة هو دراسة تأثير مسحوق حرير الذرة (Zea mays L.) والمستخلص الإيثانولي وشاي حرير الذرة على حماية الجرذان من الفشل الكلوي و الكبدى و دراسة تأثيرها على البكتيريا المسببة للأمراض. يحتوي مستخلص الإيثانول من حرير الذرة على أعلى محتوى من الفينولات والفلافونويد . تم الكشف عن سبعة عشر نوعا من الفينولات بواسطة HPLC. يحتوي على حمض الفيروليك 6118.98 ميكروغرام / غرام وهو أعلى كمية من محتوى الفينول. أظهرت مستخلصات حرير الذرة نشاطًا كيميائيًا نباتيًا ممتازًا وقدرة جيدة على مضادات الأكسدة. بالإضافة إلى ذلك ، لديهم خصائص قوية كمضادات للميكروبات. أجريت التجربة البيولوجية على ثلاثين ذكرمن الجرذان وزنها (200 ± 5 جم) لمدة ستة أسابيع وقسمت إلى خمس مجموعات ، إحداها كانت سالبه تغذت عى الوجبة الاساسية و مجموعات أعطيت الجنتاميسين بواسطة الحقن لمدة 8 أيام بمعدل جرعة 80 مجم / كجم من وزن الجسم للحث على تسمم الكبد والكلى. (المجموعة 2) الإيجابية ،اما المجموعات 3 ، 4 ، 5 عولجت بمعاملات مختلفة من حرير الذرة. أظهرت النتائج أن حرير الذرة ومستخلصه يعززان الإنزيمات المضادة للأكسدة باستخدام ديسموتاز الفائق (SOD) ، وقد تم تقييم القدرة الكلية لمضادات الأكسدة(TAC) ، وبيروكسيد الدهون على أنها malondialdehyde (MDA) ، ووظائف الكبد ، ووظائف الكلى ، والتشريح المرضي للكلى عند مقارنتها بالمجموعة الإيجابية. . في الختام ، أظهرت هذه الدراسة أن حرير الذرة له نشاط مضاد للميكروبات ضد الكائنات الحية الدقيقة المسببة للأمراض ، وتأثير الوقائي على الكلى والواقي للكبد ضد السمية الكلوية التي يسببها الجنتامايسين.

الكلمات المفتاحية: *حريرة الذرة – مضادات الميكروبات – جنتاميسين-وظائف الكلى , الكبد.*