# *The Effect of Arabic Gum, Artichoke Leaves on Rats Suffering from Renal Failure*

# تأثير الصمغ العربي و أوراق الخرشوف على الفئران المصابة بالفشل الكلوي

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# *The Effect of Arabic Gum, Artichoke Leaves on Rats Suffering from Renal Failure*

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## Abstract

The study investigated the impact of Arabic gum, Artichoke leaves, and their combinations on rats with renal failure. Rats were divided into groups, with some receiving different concentrations of Arabic gum, artichoke leaves, and their combination in their diet. Results showed that glycerol-induced renal failure caused a drop in body weight, serum protein, and antioxidant enzyme levels, while increasing kidney and liver dysfunction markers. Treatment with Arabic gum, Artichoke leaves, and their combination improved these parameters, with the best outcomes observed in rats receiving both high and low levels of the combined treatment. Histopathological analysis supported these findings, suggesting that Arabic gum and Artichoke leaves help alleviate renal failure symptoms. At the end of the biological experiment, seven samples of crepe were prepared., incorporating 2.5% and 5% Arabic gum, 2.5% and 5% Artichoke leaves, and combinations of 2.5% and 5% of both ingredients, all treatments were found to be palatable in the sensory evaluation.

## Key Words:

Renal failure, Arabic gum, Artichoke leaves, Biochemical analysis, Histopathological examination.

## Introduction:

Renal failure, a condition impacting the excretory system, is categorized into acute renal failure (ARF) and chronic renal failure (CRF) **(Abod and Taay, 2021)**. ARF has a mortality rate ranging from 25-70%, whereas CRF affects over 10% of the population, with prevalence surpassing 50% in high-risk groups **(Mohamed *et al*., 2018 and Eckardt *et al.*, 2013).** Gum Arabic (GA), a dietary fiber derived from Acacia species, is used to treat chronic kidney disease in Middle Eastern countries. In healthy mice, GA treatment enhances creatinine clearance, boosts renal excretion of antidiuretic hormone (ADH), and lowers plasma phosphate levels **(Jaafar, 2019 and Nasir *et al*., 2012).**

Gum Arabic (GA), a dried exudate from the stems of the Acacia Senegal tree, has been researched for its potential beneficial effects on the human physiological system **(Ali *et al*., 2013).** Studies have demonstrated that it can improve biochemical, physiological, and behavioral outcomes in rats with chronic renal failure and help regulate immune responses**(Ali *et al*., 2013 and Xuan *et al*., 2010)**. Gum Arabic offers numerous health benefits, including antioxidant, digestive nephroprotection, antianemic, cardiovascular, antiviral, anti-inflammatory, and hypoglycemic properties (**Jaafar , 2019 and Taha *et al*., 2020)**. It also lowers blood pressure and reduces proteinuria in diabetic mice **(Nasir *et al*., 2012).**

Artichoke, a Mediterranean plant renowned for its medicinal properties, is cultivated for its nutritional value. It comprises three main parts: the head, heart, and stalk, with the head comprising 30-40% of the plant's fresh weight **(Sokkar *et al*.,2020).** Artichoke leaf extract, rich in minerals and vitamins, is a beneficial plant with antioxidant, anti-diabetic, and anti-inflammatory properties**.** *Cynara scolymus* L, contains low fat and high levels of polyphenols, flavones, and inulin **(Sharma *et al*., 2021 and Salem *et al*., 2019)**.

*Cynara scolymus* L., also known as artichoke, has antitoxic and antiulcerogenic properties **(Heidarian *et al*., 2013 and Nassar *et al*., 2013).** Artichoke Leaves Extract ALE has shown potential as a hepatoprotective and lipid-lowering agent in clinical trials **(Heidarian and Soofiniya, 2011 and Rondanelli *et al*., 2013).** Artichoke leaf extract improves kidney function by reducing uric acid, urea, creatinine, and cholesterol in nephrotoxic rats, and increases antioxidant enzyme activity such as catalase (CAT), glutathione (GSH), and superoxide dismutase (SOD) **(EL-Bushuty, 2021)**, making it potentially beneficial for kidney conditions **(Khattab *et al*., 2016).**

Therefore, this study investigates the biological effects of a diet supplemented with Arabic gum and artichoke leaves on experimental rats with renal failure. It examines the impact on kidney histopathological changes, and it also aims to produce a safe, functional product.

## Material and Methods:

### *Materials:*

Arabic gum was sourced from Haraz Company for Agricultural Seeds, Perfumery and Medicinal Plants, Cairo, Egypt.

- Artichoke Leaves was obtained from the Agriculture Research Center in Cairo, Egypt.
- Wheat flour, corn oil, and salt were purchased from local market in Damietta governorate, Egypt.
- Casein, vitamins, minerals, cellulose, choline chloride, and glycerol were bought from El-Gomhoriya Company for Trading Drugs, Chemicals and Medical instruments, Cairo, Egypt.
- Forty-eight male Sprague Dawley rats (150 ± 10 g) were acquired from the Ministry of Health and Population's laboratory in Helwan, Cairo, Egypt.
- Biochemical analysis kits were obtained from Gamma Trade Company ,Doki, Cairo, Egypt.

### *Methods:*

#### *Preparation of Arabic gum and Artichoke Leaves:*

Artichoke leaves were dried at 50°C overnight and then ground into powder using a blender. Arabic gum was also powdered using a blender **(EI-Kholy and Mahrous, 2015).**

#### *Preparation of Crepes:*

Crepes were prepared using the following methods:

**Control:** 100% soft wheat flour. The ingredients consisted of wheat flour (100g), water (100ml) salt (2g), and corn oil (10g).

**Formulas:**

- 2.5% of wheat flour replaced with 2.5% Arabic gum.
- 5% of wheat flour replaced with 5% Arabic gum.
- 2.5% of wheat flour replaced with 2.5% Artichoke leaves.
- 5% of wheat flour replaced with 5% Artichoke leaves.
- 5% of wheat flour replaced with 2.5% Artichoke leaves and 2.5% Arabic gum.
- 10% of wheat flour replaced with 5% Artichoke leaves and 5% Arabic gum.

Crepes were made using the straight dough method **(A.A.C.C., 2002).**

**Chemical analysis:**

Moisture content, total protein, crude fat, fiber, and ash in artichoke leaves were measured using **A.O.A.C. (1990)** methods. Carbohydrates were calculated by difference: Carbohydrates (%) = 100 – (moisture + fat + protein + crude fiber + ash). As well as total phenolics and total Flavonoids were determined according to **Talla *et al*. (2014).**

**Experimental Design:**

Forty-eight male Sprague Dawley albino rats (150±10 g) were individually housed in stainless steel cages at 25°C, 50% humidity, with a 12-hour light/dark cycle. They were fed a basal diet and given water for one week for adaptation. The experiment adhered to national animal welfare regulations. The basal diet, based on **Reeves *et al*. (1993)**, contained 14% protein, 10% sucrose, 4% corn oil, 0.25% choline chloride, 1% vitamin mix **(Campbell, 1963)**, 3.5% salt mix **(Hegsted *et al*., 1941)**, and 5% fiber. The remainder was corn starch.

After the adaptation period on the basal diet, the rats were divided into two main groups. The first main group (6 rats) was fed a basal diet as a negative control. Acute renal failure was induced in the second main group (42 rats) with glycerol (50% w/v in 0.9% saline, 10 ml/kg) following **Maree *et al*. (1994)**. The infected rats were then divided into seven subgroups (n=6) as follows: Subgroup (1) was fed a basal diet as a positive control. Subgroups (2) and (3) were fed diets containing 2.5% and 5% Arabic gum powder, respectively. Subgroups (4) and (5) were fed diets containing 2.5% and 5% artichoke leaf powder, respectively. Subgroups (6) and (7) were fed diets containing combinations of 2.5% Arabic gum powder and 2.5% artichoke leaf powder, and 5% Arabic gum powder and 5% artichoke leaf powder, respectively.

During the 6-week experiment, diets and body weights were recorded weekly. At the end, rats were fasted overnight, anesthetized, and sacrificed. Blood samples were collected from the aorta, centrifuged, and serum separated for biochemical analysis. Parameters measured included serum uric acid **(Fossati *et al*., 1980)**, urea nitrogen **(Patton and Crouch, 1977)**, creatinine **(Bartels and Bohmer, 1971)**, AST **(Henry, 1974)[a]** and ALT **(Henry, 1974)[b]**, ALP **(Belfield and Goldberg, 1971)**, protein **(Gornal *et al*., 1949)**, albumin **(Doumas and Biggs, 1971)**, and antioxidant enzymes GPx **(Aebi, 1984)**, SOD **(Beauchamp and Fridovich, 1971)**, CAT **(Paglia and Valentine, 1967)**, and FER **(Chapman *et al*.,1959).**

## Histopathological Examination:

Kidney tissue specimens were taken immediately after sacrificing the animal, fixed in 10% buffered formalin, then trimmed, washed, and dehydrated. They were embedded in paraffin, sectioned at 4-6 microns, and stained with hematoxylin and eosin **(Sheehan and Hrapchack, 1980)**.

## Statistical Analysis:

Data were statistically analyzed using a computer, with results expressed as mean ± SD and significance tested via one-way analysis of variance ANOVA test, according to **(Armitage and Berry, 1987)**.

## Results and Discussion

### *Chemical Composition of Artichoke leaves (per 100g dry weight):*

Table (1) shows that dried artichoke leaves have a composition of 5.22% moisture, 15.70% protein, 28.00% crude fiber, 3.42% total lipids, 8.55% ash, and 39.11% carbohydrates. Additionally, they contain 63.77 mg of total phenolic and 19.50 mg of total flavonoids per 100 grams.

**Table (1): Chemical Composition of Artichoke Leaves (g/ 100 g dry weight)**

| Components | Amount |
|---|---|
| Moisture | **5.22** |
| Protein | **15.70** |
| Crude Fiber | **28.00** |
| Total Lipid | **3.42** |
| Ash | **8.55** |
| Carbohydrates | **39.11** |
| Total phenolic (mg gallic/100 gm) | 63.77 |
| Total Flavonoids (mg catechin/100 gm) | 19.50 |

**These results are the average of two estimates**

In this respect, **El Sohaimy (2013)** reported that fresh artichoke leaves contain 75.8% moisture. **Ben Salem *et al*. (2017)** found that the protein content in artichoke leaves is 16.64 g/100 g. According to **Hosseinzadeh *et al*. (2013)**, the fat content of artichoke leaves ranges from 1.6% to 2.3% on a dry weight basis. **Al-Subhi (2017)** reported a fiber content of 32.41% in artichoke leaves, which is higher than the 29.61% found in artichoke heads. **Mosaed and Al-Subhi (2017)** reported an ash content of 9.52±0.18% in artichoke leaves, while **El Sohaimy (2013)** found the ash content to be 7.21%.

Phenolic compounds are essential antioxidants in plants, with dried artichoke leaves containing 60.99 mg of total phenolic per 100 grams. These compounds are effective at scavenging free radicals, protecting the body from oxidative stress, and helping to prevent chronic diseases such as cardiovascular diseases, cancers, and neurodegenerative disorders **(Pandey and Rizvi, 2009).**

Flavonoids, a diverse group of phytonutrients in most fruits and vegetables, are crucial for human health. Artichoke leaves are particularly rich in flavonoids, with 25.50 mg per 100 grams. These compounds have anti-inflammatory, anti-carcinogenic, and cardioprotective properties, and they reduce the risk of chronic diseases by modulating cell signaling pathways and enzyme activities **(Panche *et al*., 2016).**

**Effect of Arabic Gum, Artichoke Leaves, and Their Combination on the Nutritional Status of Rats Suffering from Renal Failure.**

The study investigates the impact of Arabic gum and artichoke leaves on feed intake, body weight, and weight gain percentage in rats with acute renal failure. The results are detailed in Table 2. The study found no significant differences in mean feed intake values among treated groups with acute renal failure compared to both negative and positive control groups. The study found no significant changes in initial body weight among acute renal failure groups treated with Arabic gum, artichoke leaves, or their combination compared to the negative and positive control groups. The data in this table 2 showed that the final body weight of the positive control group decreased significantly ($p \leq 0.05$) compared to the negative control group ($167.80 \pm 6.300$ g vs. $190.40 \pm 6.188$ g). Rats injected with glycerol showed an approximately 11.869% decrease in mean final body weight compared to non-injected rats.

Final body weight decreased in all treated groups, with a significant reduction observed in groups treated with a diet containing 5% Arabic gum, a combination of 2.5% Arabic gum and 2.5% artichoke leaves, and a combination of 5% Arabic gum and 5% artichoke leaves, compared to the positive control group.

Table 2 indicates a significant decrease in the mean body weight gain percentage (BWG%) of glycerol-injected rats compared to non-injected rats, with values of $10.368 \pm 0.779\%$ and $24.957 \pm 1.638\%$, respectively. The study found that acute renal failure groups treated with Arabic gum, artichoke leaves, or their combinations exhibited a significant decrease in BWG% compared to the control groups. The most pronounced decrease was observed in acute renal failure groups treated with 5% Arabic gum or combinations of 2.5% Arabic gum

+ 2.5% artichoke leaves and 5% Arabic gum + 5% artichoke leaves, showing a significant reduction ($p \leq 0.05$) compared to the other treated groups.

**Table (2): Effect of Arabic Gum, Artichoke Leaves, and Their Combination on the Nutritional Status of Rats Suffering from Renal Failure**

| Groups \ Parameters | | Feed intake (g/day/ each rat) | Initial weight (g) | Final weight (g) | BWG% |
|---|---|---|---|---|---|
| Control (-ve) | | 17.400 $^{a}$ ± 1.140 | 152.40 $^{a}$ ± 5.594 | 190.40 $^{a}$ ± 6.188 | 24.957 $^{a}$ ± 1.638 |
| **Acute renal failure fed on** | BD, Control (+ve) | 16.600 $^{a}$ ± 1.949 | 152.00 $^{a}$ ± 5.656 | 167.80 $^{b}$ ±6.300 | 10.368 $^{b}$ ± 0.779 |
| | Diet containing 2.5% Arabic gum | 17.000 $^{a}$ ± 1.732 | 152.00 $^{a}$ ± 5.322 | 161.00 $^{b\ c}$ ± 5.338 | 6.081 $^{d}$ ± 1.074 |
| | Diet containing 5% Arabic gum | 17.400 $^{a}$ ± 1.673 | 153.00 $^{a}$ ± 6.480 | 156.80 $^{c}$ ± 4.494 | 2.904 $^{e}$ ± 0.830 |
| | Diet containing 2.5% artichoke leaves | 17.200 $^{a}$ ± 2.167 | 151.80 $^{a}$ ± 5.890 | 163.40 $^{b\ c}$ ± 5.683 | 7.508 $^{c}$ ± 0.460 |
| | Diet containing 5% artichoke leaves | 16.400 $^{a}$ ± 2.190 | 152.40 $^{a}$ ± 5.272 | 160.80 $^{b\ c}$ ± 5.357 | 5.131 $^{d}$ ± 1.146 |
| | Diet containing 2.5% Arabic gum and 2.5% artichoke leaves | 16.800 $^{a}$ ± 2.774 | 152.60 $^{a}$ ± 6.913 | 156.80 $^{c}$ ± 8.348 | 2.724 $^{e}$ ± 1.072 |
| | Diet containing 5% Arabic gum and 5% artichoke leaves | 16.800 $^{a}$ ± 2.280 | 152.80 $^{a}$ ± 3.420 | 156.00 $^{c}$ ± 3.674 | 1.838 $^{e}$ ± 0.579 |

*BD: Basal diet  Each value is shown as mean ± standard deviation*
*Mean values in each column with same letters are not significantly different.*
*Significant differences at ($p \leq 0.05$)*

Glycerol-induced acute renal failure in rats led to decreased final body weight and body weight gain. **Ali *et al*. (2019)** also reported reduce feed intake and body weight gain in glycerol-injected rats. Our study found that diets with 2.5% and 5% Arabic gum and artichoke leaves reduced final body weight and weight gain. Research by **Howarth *et al*. (2001) and Chandalia *et al*. (2000)** indicates that Gum Arabic decreases BMI and body fat, with evidence suggesting it may reduce caloric intake and increase satiety **(Calame *et al*., 2011).**

Elevated ALT and AST levels are associated with obesity and BMI **(Clark *et al*., 2003).** Cynara scolymus, or artichoke extract, may improve liver function and aid weight loss. Studies show it reduces weight gain, cholesterol, and triglycerides in hyperlipidemic rats **(Rodriguez *et al*., 2002)** and protects

liver cells from oxidative stress **(Heidarian *et al*., 2013). Abdulkhaleq *et al*. (2018)** found that artichoke extract reduced body weight gain in rats on a high-fat diet, while **Rangboo *et al*. (2016)** reported that Cynara scolymus extract improved liver enzyme levels and reduced weight and blood pressure in individuals with nonalcoholic steatohepatitis.

**Effect of Arabic Gum, Artichoke Leaves, and Their Combination on feed efficiency ratio FER (g/day) of Rats Suffering from Renal Failure.**

The data presented in Table 3 indicate a significant decrease in the mean feed efficiency ratio (FER) in glycerol-injected rats (positive control group) compared to non-injected rats (negative control group). The FER values were 0.0338 ± 0.006 for the injected group, versus 0.077 ± 0.005 for the non-injected group.

**Table (3): Effect of Arabic Gum, Artichoke Leaves, and Their Combination on feed efficiency ratio FER (g/day) of Rats Suffering from Renal Failure.**

| Groups \ Parameters | | FER | %Change of control (+) positive |
|---|---|---|---|
| **Control (-ve)** | | 0.077 [a] ± 0.005 | 127.81 |
| **Acute renal failure fed on** | **BD, Control (+ve)** | 0.0338 [b] ± 0.006 | - |
| | **Diet containing 2.5% Arabic gum** | 0.0187 [c] ± 0.003 | -44.67 |
| | **Diet containing 5% Arabic gum** | 0.0072 [d] ± 0.005 | -78.70 |
| | **Diet containing 2.5% artichoke leaves** | 0.024 [c] ± 0.008 | -28.99 |
| | **Diet containing 5% artichoke leaves** | 0.018 [c] ± 0.003 | -46.74 |
| | **Diet containing 2.5% Arabic gum and 2.5% artichoke leaves** | 0.010 [d] ± 0.005 | -70.41 |
| | **Diet containing 5% Arabic gum and 5% artichoke leaves** | 0.006 [d] ± 0.002 | -82.25 |

*BD: Basal diet  Each value is shown as mean ± standard deviation*
*Mean values in each column with same letters are not significantly different.*
*Significant differences at ($p \leq 0.05$)*

All acute renal failure groups treated with 2.5% and 5% Arabic gum, 2.5% and 5% Artichoke leaves, and their combinations showed a significant reduction in FER ($p \leq 0.05$) compared to both the positive and negative control groups. FER decreased gradually with increasing the level of Arabic gum,

artichoke leaves, and their combinations in the diets. This decrease in feed efficiency ratio is due to the weight loss of rats treated with Arabic gum and artichoke leaves.

Regarding this matter, **Ali *et al*. (2019)** found that rats injected with glycerol to induce acute renal failure experienced a significant decrease in feed intake, body weight gain percentage, and feed efficiency ratio compared to non-injected rats.

**Effect of Arabic Gum, Artichoke Leaves, and Their Combination on Kidney Function in Rats with Renal Failure**

The study evaluates how Arabic gum, artichoke leaves, and their combinations at two concentrations affect kidney function indicators (serum uric acid, urea nitrogen, and creatinine "mg/dl") in rats with acute renal failure, as detailed in (Table 4). Glycerol-induced acute renal failure in rats led to a 140.38 % increase in serum uric acid levels compared to the control. Rats fed diets with Arabic gum, artichoke leaves, or their combination had significantly lower serum uric acid. The greatest reduction was observed in rats given a 5% Arabic gum and 5% artichoke leaves combination, followed by the 2.5% combination and then the 5% artichoke leaves diet.

Normal rats had a mean serum urea nitrogen of 49.200 ± 4.207 mg/dl, while ARF rats had 76.800 ± 6.942 mg/dl. All ARF groups receiving Arabic gum, artichoke leaves, or both showed significant reductions in serum urea nitrogen compared to the positive control. The best results were seen in the group fed a 5% Arabic gum and 5% artichoke leaves combination, followed by the 2.5% combination and the 5% Arabic gum group.

The study showed a 128.571% increase in serum creatinine in rats with glycerol-induced acute renal failure compared to healthy rats. All treatment groups had significantly lower serum creatinine levels than the positive control. The table shows no significant difference in serum creatinine among ARF groups treated with 2.5% Arabic gum, 5% Arabic gum, and 2.5% artichoke leaves. The greatest decrease in serum creatinine was seen in the group receiving a combination of 5% Arabic gum and 5% artichoke leaves, followed by the 2.5% combination and 5% artichoke leaves groups.

The study found that rats injected with glycerol to induce acute renal failure showed a significant increase in serum uric acid, urea nitrogen, and creatinine levels. In this respect **Choi *et al*. (2004)** suggest that glycerol injection in rats may increase uric acid levels due to altered purine metabolism. **Ronco (2004)** indicates that elevated urea nitrogen levels could signal impaired renal function from glycerol's effects on the kidneys. **Levey *et al*. (1999)** reported that post-glycerol injection, higher creatinine levels suggest kidney dysfunction, as increased bloodstream creatinine indicates compromised kidney filtration.

**Table (4): Effect of Arabic Gum, Artichoke Leaves, and Their Combination on Kidney Functions of Rats Suffering from Acute Renal Failure.**

| Groups \ Parameters | | Uric acid | Urea nitrogen | Creatinine |
|---|---|---|---|---|
| | | mg/dl | | |
| Control (-ve) | | 1.040 $^{c}$ ± 0.130 | 49.200 $^{d}$ ± 4.207 | 0.560 $^{d}$ ± 0.054 |
| **Acute renal failure fed on** | BD, Control (+ve) | 2.500 $^{a}$ ± 0.158 | 76.800 $^{a}$ ± 6.942 | 1.280 $^{a}$ ± 0.083 |
| | Diet containing 2.5% Arabic gum | 1.240 $^{b}$ ± 0.114 | 62.000 $^{b}$ ± 3.535 | 0.760 $^{b}$ ± 0.054 |
| | Diet containing 5% Arabic gum | 1.040 $^{c}$ ± 0.054 | 55.200 $^{c}$ ± 4.919 | 0.680 $^{b c}$ ± 0.083 |
| | Diet containing 2.5% artichoke leaves | 1.260 $^{b}$ ± 0.114 | 57.200 $^{b c}$ ± 2.588 | 0.760 $^{b}$ ± 0.089 |
| | Diet containing 5% artichoke leaves | 1.140 $^{b c}$ ± 0.114 | 52.000 $^{c d}$ ± 3.082 | 0.700 $^{c}$ ± 0.070 |
| | Diet containing 2.5% Arabic gum and 2.5% artichoke leaves | 1.180 $^{b c}$ ± 0.083 | 55.200 $^{c}$ ± 2.774 | 0.620 $^{c d}$ ± 0.083 |
| | Diet containing 5% Arabic gum and 5% artichoke leaves | 1.080 $^{c}$ ± 0.083 | 52.000 $^{c d}$ ± 2.549 | 0.580 $^{d}$ ± 0.044 |

*BD: Basal diet  Each value is shown as mean ± standard deviation*
*Mean values in each column with same letters are not significantly different.*
*Significant differences at ($p \leq 0.05$)*

Adding Arabic gum and artichoke leaves (at 2.5% and 5%) to the diets of rats with acute renal failure reduced serum uric acid, urea nitrogen, and creatinine levels compared to the positive control groups. The greatest improvements were observed with combinations of (2.5% Arabic gum + 2.5% artichoke leaves) and (5% Arabic gum + 5% artichoke leaves), followed by diets with higher individual levels of Arabic gum and artichoke leaves. In this respect **Aburjai *et al*. (2007)** found that Arabic gum, a natural exudate from Acacia trees, has potential renal protective effects in animal models of acute renal failure due to its anti-inflammatory and antioxidant properties. **Al-Majed *et al*. (2002)** suggested that Arabic gum supplementation can improve kidney function markers in rats with acute renal failure by reducing uric acid, urea nitrogen, and creatinine levels. **El-Tahir and Bakeet (2006)** also reported that Arabic gum's antioxidant and anti-inflammatory properties can enhance kidney function by mitigating oxidative stress and inflammation, which are common contributors to kidney damage.

**Said *et al*. (2019)** reported that Gum Arabic (GA) is used in developing countries to treat chronic kidney disease (CKD) by lowering serum urea nitrogen and increasing fecal nitrogen excretion, thereby reducing uric acid levels. **Elamin *et al*. (2017)** found that supplementing CKD patients' diets with 10-40g/day of GA significantly reduced C-reactive protein levels without affecting blood urea nitrogen. GA is believed to boost energy for intestinal bacteria that ferment dietary fibers and use the host's nitrogen waste **(Ali *et al*., 2009).** Consuming fermentable fibers increases cecum size, reduces plasma urea by 30%, and enhances urea nitrogen uptake and excretion **(Younes *et al*., 2006).** Gum Arabic, used as an emulsifier and stabilizer in various industries, is also traditionally used in Middle Eastern countries like Sudan to treat chronic kidney disease **(Ali *et al*., 2009).** In CKD patients, it boosts fecal nitrogen excretion and reduces serum urea nitrogen by enhancing gut bacterial growth and activity **(Bliss *et al*., 1996).**

Regarding artichoke leaves, **El Daly *et al*. (2011)** found that artichoke leaf extract reduced serum uric acid, urea nitrogen, and creatinine in rats with acute renal failure, suggesting improved renal health. **Ahmed *et al*. (2011)** reported that administering 400 mg/kg of artichoke significantly reduced urea levels and plasma creatinine in rats. **Khattab *et al*. (2016)** reported that artichoke leaf extract (ALE) significantly lowered blood urea, uric acid, and creatinine levels in rats with gentamycin-induced renal dysfunction. **Ben Salem *et al*. (2017)** found that administering artichoke head at 200 and 400 mg/kg improved renal dysfunction in diabetic rats.

**Kollia *et al*. (2017)** found that artichoke's flavonoids and caffeoylquinic acids possess antioxidant properties. **Najim *et al*. (2018)** showed that artichoke methanol extract can alleviate 5-Fluorouracil-induced nephrotoxicity in albino rats. **Fadlalla and Galal (2020)** demonstrated that ALE treatment mitigates histological and biochemical liver and kidney damage, as well as oxidative stress, caused by paracetamol.

## Effect of Arabic Gum, Artichoke Leaves, and Their Combination on Liver Enzymes of Rats Suffering from Acute Renal Failure

The study evaluates the impact of Arabic gum, artichoke leaves, and their combinations at two levels on liver enzymes (AST, ALT, and ALP) in rats with acute renal failure, as detailed in Table (5). Glycerol-injected rats with acute renal failure showed a significant increase in serum AST levels (249.40 ± 5.594 U/l) compared to non-injected rats (168.60 ± 2.701 U/l), with a 47.92% increase in the ARF group compared to the negative control group.

All ARF groups treated with diets containing 2.5% or 5% Arabic gum, 2.5% or 5% artichoke leaves, and combinations of 2.5% Arabic gum + 2.5% artichoke leaves or 5% Arabic gum + 5% artichoke leaves showed a significant decrease in serum AST levels compared to the positive control group ($P \leq 0.05$). The smallest decrease in serum AST levels was observed in the groups fed 2.5% Arabic gum or 2.5% artichoke leaves. The greatest decrease was seen in the group fed a combination of 5% Arabic gum and 5% artichoke leaves, followed by the combination of 2.5% Arabic gum and 2.5% artichoke leaves. Treatment with 5% Arabic gum and 5% artichoke leaves, or 2.5% Arabic gum and 2.5% artichoke leaves, reduced serum AST levels by approximately 30.713% and 28.388%, respectively, compared to the positive control group.

Glycerol-injected rats with acute renal failure had a significant increase in serum ALT levels (65.00 ± 6.670 U/l) compared to non-injected rats (49.40 ± 6.107 U/l), showing a 31.578% increase in the ARF group compared to the negative control group. All tested diets significantly reduced serum ALT levels compared to the positive control group ($P \leq 0.05$). Among the treated ARF groups, only the diet containing a combination of 5% Arabic gum and 5% artichoke leaves showed a significant decrease in serum ALT compared to the other diets. The greatest decrease in serum ALT was observed in the group fed a combination of 5% Arabic gum and 5% artichoke leaves, followed by 5% Arabic gum, 2.5% Arabic gum + 2.5% artichoke leaves, and 5% artichoke leaves. A diet with a mix. of 5% Arabic gum and 5% artichoke leaves reduced serum ALT levels by approximately 27.692% in ARF rats compared to the positive control group.

Glycerol-induced acute renal failure significantly increased serum ALP levels (822.40 ± 42.81 U/l) compared to non-treated rats (599.00 ± 8.544 U/l), showing a 37.295% increase in the ARF group compared to the negative control. Arabic gum, artichoke leaves, and their combinations significantly reduced serum ALP levels compared to the positive control group. The smallest reduction was in the group fed 2.5% Arabic gum (659.60 ± 11.282 U/l), while the greatest reduction was in the group fed a combination of 5% Arabic gum and 5% artichoke leaves (623.80 ± 22.027 U/l).

**Table (5): Effect of Arabic Gum, Artichoke Leaves, and Their Combination on Liver Enzymes of Rats Suffering from Acute Renal Failure**

| Groups \ Parameters | | AST | ALT | ALP |
|---|---|---|---|---|
| | | U/l | | |
| Control (-ve) | | 168.60 $^{e}$ ± 2.701 | 49.40 $^{c\ d}$ ± 6.107 | 599.00 $^{d}$ ± 8.544 |
| **Acute renal failure fed on** | BD, Control (+ve) | 249.40 $^{a}$ ± 5.594 | 65.00 $^{a}$ ± 6.670 | 822.40 $^{a}$ ± 42.81 |
| | Diet containing 2.5% Arabic gum | 195.60 $^{b}$ ± 1.816 | 55.00 $^{b\ c}$ ± 1.870 | 659.60 $^{b}$ ± 11.282 |
| | Diet containing 5% Arabic gum | 187.00 $^{c}$ ± 1.581 | 51.60 $^{b\ c\ d}$ ± 4.159 | 648.80 $^{b\ c}$ ± 5.215 |
| | Diet containing 2.5% artichoke leaves | 196.40 $^{b}$ ± 3.049 | 57.40 $^{b}$ ± 5.319 | 647.20 $^{b\ c}$ ± 27.151 |
| | Diet containing 5% artichoke leaves | 195.80 $^{b}$ ± 3.768 | 53.40 $^{b\ c}$ ± 2.509 | 634.60 $^{b\ c}$ ± 8.648 |
| | Diet containing 2.5% Arabic gum and 2.5% artichoke leaves | 178.60 $^{d}$ ± 7.300 | 53.20 $^{b\ c}$ ± 2.774 | 628.20 $^{c}$ ± 9.884 |
| | Diet containing 5% Arabic gum and 5% artichoke leaves | 172.80 $^{e}$ ± 3.701 | 47.00 $^{d}$ ± 2.549 | 623.80 $^{c\ d}$ ± 22.027 |

*BD: Basal diet* *Each value is shown as mean ± standard deviation*
*Mean values in each column with same letters are not significantly different.*
*Significant differences at ($p \leq 0.05$)*

Glycerol-induced acute renal failure significantly increased serum levels of AST, ALT, and ALP in rats compared to non-injected rats, indicating liver damage. This elevation is likely due to the systemic effects of renal damage, though the exact mechanism is not fully understood **(Amirkhanlou *et al*., 2019).**

Diets containing 2.5% and 5% Arabic gum or artichoke leaves improved serum AST, ALT, and ALP levels in rats with ARF compared to the positive control group. The combination of Arabic gum and artichoke leaves also significantly enhanced these enzyme levels more than the positive control and other treatments. In this regard, **Babiker *et al*. (2017)** found that daily gum Arabic for twelve weeks significantly improved liver antioxidant activity in Sprague-Dawley rats. **Hamid *et al*. (2021)** reported that GA enhances hepatic apoptosis, reduces oxidative stress, and improves inflammation in rats with induced hepatotoxicity. GA has strong antioxidant properties, reduces lipid peroxidation, and offers anti-inflammatory, antimicrobial, antidiarrheal, anti-obesity, and antihypertensive effects **(Elshama, 2018).**

GA may protect the liver from acetaminophen toxicity by reducing oxidative stress, blocking liver macrophage function, and improving antioxidant status, potentially preventing liver damage **(Pal *et al*., 2014). Al-Kenanny *et al*. (2012)** found that GA can reduce liver damage in mice by improving AST and ALT levels, though these levels did not return to normal.

Regarding artichokes, **Mulinacci *et al*. (2004)** noted that artichoke, rich in natural antioxidants, is widely used as an herbal remedy. **Kulza *et al*. (2010)** reported that artichoke also has hepatoprotective properties. Research indicates that artichoke leaf extract provides hepatoprotection, treating liver diseases such as toxin-induced and alcoholic hepatitis, and reduces oxidative stress and liver enzymes in rats **(Speroni *et al*., 2003; Kumar and Khanna, 2018; El-Mesallamy *et al*., 2020).**

Artichoke leaves, rich in cynarin and chlorogenic acid, enhance liver health by improving liver enzymes, boosting bile production, and supporting detoxification **(Gebhardt and Fausel, 1997).** On the other hand, **Rondanelli (2016)** highlights that artichoke leaf extract has hepatoprotective and anti-inflammatory benefits, largely due to flavonoids luteolin and apigenin, which suppress inflammation and enhance liver function.

**Panahi *et al*. (2018)** found that artichoke leaf extract (ALE) may protect the liver in NAFLD patients by increasing hepatic vein flow, reducing liver size, and lowering cholesterol levels, suggesting therapeutic benefits. Also, **Liao *et al*. (2021)** reported that artichoke leaf extract may alleviate oxidative stress, inflammation, and lipid metabolism disorders in steatohepatitis and liver damage caused by a high-fat, high-cholesterol diet.

**Effect of Arabic Gum, Artichoke Leaves, and Their Combination on Protein Status of Rats Suffering from Acute Renal Failure**

This thesis examines how Arabic gum and artichoke leaves, both separately and in combination at two levels, affect serum protein, albumin, globulin, and their ratio in rats with acute renal failure, as detailed in Table (6). Glycerol-injected rats with acute renal failure showed a significant decrease in serum protein levels (5.28 ± 0.164 g/l) compared to non-injected rats (7.28 ± 0.192 g/l), with a 27.47% reduction in the ARF group compared to the negative control.

The addition of Arabic gum, artichoke leaves, and their combinations significantly increased serum protein levels ($P \leq 0.05$) compared to the positive control group. The largest increase was in the group fed a combination of 5% Arabic gum and 5% artichoke leaves (6.80 ± 0.122 g/l), followed by 5% artichoke leaves (6.60 ± 0.200 g/l). The smallest increase was seen in the group

with 2.5% Arabic gum (6.06 ± 0.230 g/l). The ARF group fed a diet with 5% Arabic gum and 5% artichoke leaves had the best results, increasing serum protein levels by about 28.78% compared to the positive control group.

Glycerol-injected rats with acute renal failure had a significant decrease in serum albumin levels (2.16 ± 0.114 g/l) compared to non-injected rats (4.66 ± 0.378 g/l), with a 53.64% reduction in the ARF group. All treated ARF groups with Arabic gum, artichoke leaves, or their combinations showed significant increases in serum albumin compared to the positive control group, with the best results from diets containing 5% Arabic gum and 5% artichoke leaves or combinations of 2.5% Arabic gum and 2.5% artichoke leaves.

Glycerol-injected rats with acute renal failure showed a significant increase in serum globulin levels (28.925% higher) compared to the negative control group. All ARF groups treated with Arabic gum, artichoke leaves, or their combinations significantly reduced serum globulin compared to the positive control group. The greatest reduction was seen in the group treated with 5% Arabic gum, followed by the combination of 2.5% Arabic gum and 2.5% artichoke leaves (Table 5).

Glycerol-injected rats with acute renal failure had a significant decrease in the serum albumin-to-globulin ratio (0.696 ± 0.037 g/l) compared to non-injected rats (1.932 ± 0.161 g/l), with a 63.975% reduction. All treated groups significantly improved this ratio compared to the positive control group, with no significant differences among treatments except for the group with 2.5% artichoke leaves.

Glycerol-induced acute renal failure in rats caused significant drops in serum protein and albumin levels and a reduced albumin/globulin ratio, while increasing globulin levels. This condition leads to inflammation, oxidative stress, and kidney damage, disrupting protein metabolism and altering serum protein levels **(Zager & Gamelin, 1989).** Studies by **Gobe *et al*. (1999)** and **Tanaka *et al*. (1999)** also noted decreased serum albumin and a reduced albumin/globulin ratio, indicating impaired liver function or increased kidney loss. **Ruderman (1999)** noted that while albumin levels decreased in glycerol-injected rats, average globulin levels increased, likely due to enhanced synthesis of certain globulin types.

**Table (6): Effect of Arabic Gum, Artichoke Leaves, and Their Combination on Protein Status of Rats Suffering from Acute Renal Failure**

| Groups \ Parameters | | Protein (g/l) | Albumin (g/l) | Globulin (g/l) | Alb. / Glob (g/l) |
|---|---|---|---|---|---|
| Control (-ve) | | 7.28 $^{a}$ ± 0.192 | 4.66 $^{a}$ ± 0.378 | 2.42 $^{e}$ ± 0.258 | 1.932 $^{a}$ ± 0.161 |
| **Acute renal failure fed on** | BD, Control (+ve) | 5.28 $^{e}$ ± 0.164 | 2.16 $^{d}$ ± 0.114 | 3.12 $^{a}$ ± 0.109 | 0.696 $^{d}$ ± 0.037 |
| | Diet containing 2.5% Arabic gum | 6.06 $^{d}$ ± 0.230 | 3.48 $^{c}$ ± 0.178 | 2.58 $^{d e}$ ± 0.192 | 1.354 $^{b}$ ± 0.122 |
| | Diet containing 5% Arabic gum | 6.40 $^{c}$ ± 0.151 | 3.76 $^{b}$ ± 0.089 | 2.64 $^{c d}$ ± 0.089 | 1.424 $^{b}$ ± 0.040 |
| | Diet containing 2.5% artichoke leaves | 6.38 $^{c}$ ± 0.130 | 3.46 $^{c}$ ± 0.114 | 2.92 $^{a b}$ ± 0.083 | 1.164 $^{c}$ ± 0.065 |
| | Diet containing 5% artichoke leaves | 6.60 $^{b c}$ ± 0.200 | 3.78 $^{b}$ ± 0.083 | 2.82 $^{b c}$ ± 0.148 | 1.340 $^{b}$ ± 0.064 |
| | Diet containing 2.5% Arabic gum and 2.5% artichoke leaves | 6.52 $^{c}$ ± 0.130 | 3.800 $^{b}$ ± 0.122 | 2.76 $^{b c d}$ ± 0.151 | 1.378 $^{b}$ ± 0.082 |
| | Diet containing 5% Arabic gum and 5% artichoke leaves | 6.80 $^{b}$ ± 0.122 | 3.98 $^{b}$ ± 0.083 | 2.84 $^{b c}$ ± 0.151 | 1.400 $^{b}$ ± 0.101 |

*BD: Basal diet Each value is shown as mean ± standard deviation Significant differences at ($p \leq 0.05$) Mean values in each column with same letters are not significantly different.*

Adding 2.5% and 5% Arabic gum and artichoke leaves to the diets of ARF-afflicted rats improved serum protein, albumin, globulin levels, and the albumin/globulin ratio compared to the positive control. The combination of Arabic gum and artichoke leaves significantly enhanced serum protein and albumin levels, and the albumin/globulin ratio, while reducing globulin levels in ARF rats. **Ibrahim *et al*. (2018)** noted that Arabic gum may improve renal function, protein levels, and offer protection against kidney injury. Studies show that Arabic gum improves serum protein levels in kidney injury models, thanks to its anti-inflammatory and antioxidant properties, which help preserve glomerular filtration and maintain albumin and globulin levels **(Sulieman *et al*., 2014).**

Artichoke leaves offer hepatoprotective and antioxidative benefits, potentially improving liver and kidney function and affecting serum protein levels **(Gebhardt , 1997).** Rich in compounds like cynarin and flavonoids, they may enhance liver function and, indirectly, serum protein levels **(El-Lakkany *et al*., 2011).** Studies also suggest that both Arabic gum and artichoke leaves can benefit kidney function: Arabic gum may protect renal tissues and improve serum proteins in acute renal failure, while artichoke leaves' antioxidant properties may mitigate kidney damage and improve renal function **(Bashir *et al*., 2013; Ali *et al*., 2014; El-Boshy *et al*., 2015and Salem *et al*., 2017).**

**Effect of Arabic Gum, Artichoke Leaves, and Their Combination on Antioxidant Enzymes of Rats Suffering from Acute Renal Failure.**

The study examines how Arabic gum and artichoke leaves, both alone and in combination at two levels, affect antioxidant enzymes (GPX, SOD, and catalase) in rats with acute renal failure. Results are shown in Table (7).

The data in Table (7) show that glycerol-injected rats with acute renal failure had a 75.045% decrease in serum GPX levels compared to non-injected rats on the same diet (137.00 ± 5.00 vs. 549.00 ± 13.453 mu/ml). The results showed that diets containing Arabic gum, artichoke leaves, or their combination significantly increased GPX levels in rats with acute renal failure compared to the positive control. The highest GPX increase was seen in rats fed a diet containing a combination of 5% Arabic gum and 5% artichoke leaves, followed by 2.5% Arabic gum and 2.5% artichoke leaves, and then 5% artichoke leaves alone.

In normal rats, the average serum SOD level was 242.00 ± 4.582 u/ml, while in ARF rats it was 164.333 ± 6.027 u/ml. ARF rats fed diets with Arabic gum, artichoke leaves, or their combination had significantly higher SOD levels than the positive control. The highest SOD levels were found in rats fed 5% Arabic gum and 5% artichoke leaves, followed by 2.5% Arabic gum and 2.5% artichoke leaves, and then 5% Arabic gum or 5% artichoke leaves alone (Table 6).

Rats with glycerol-induced acute renal failure had significantly lower serum catalase levels (254.33 ± 31.722 u/ml) compared to healthy rats (403.00 ± 20.223 u/ml), representing a 52.439% decrease. All treated ARF groups showed significant increases in serum catalase compared to the positive control. The highest increase was observed in the group treated with 5% Arabic gum, followed by those with 2.5% Arabic gum, and various combinations of Arabic gum and artichoke leaves.

Rats with glycerol-induced acute renal failure showed significant reductions in antioxidant enzymes (GPX, SOD, and catalase) compared to healthy rats. These enzymes are crucial for counteracting oxidative stress: GPX neutralizes peroxides, SOD targets superoxide radicals, and catalase decomposes hydrogen peroxide. Reduced activity of these enzymes impairs the kidney's ability to handle reactive oxygen species (ROS), exacerbating oxidative damage and renal dysfunction. Glycerol injection increases ROS production, leading to oxidative stress and decreased antioxidant enzyme levels in the kidneys **(Rasheed *et al*., 2015; Pari and Latha, 2004).**

**Table (7): Effect of Arabic Gum, Artichoke Leaves, and Their Combination on Antioxidant Enzymes of Rats Suffering from Acute Renal Failure**

| Groups \ Parameters | | GPX mu/ml | SOD u/ml | Catalase u/ml |
|---|---|---|---|---|
| Control (-ve) | | 549.00 [a] ± 13.453 | 242.00 [a] ± 4.582 | 403.00 [a] ± 20.223 |
| Acute renal failure fed on | BD, Control (+ve) | 137.00 [g] ± 5.00 | 164.333 [e] ± 6.027 | 254.33 [d] ± 31.722 |
| | Diet containing 2.5% Arabic gum | 278.00 [e] ± 5.567 | 198.33 [d] ± 7.094 | 328.66 [bc] ± 13.503 |
| | Diet containing 5% Arabic gum | 298.00 [e] ± 2.645 | 211.00 [bc] ± 4.582 | 365.00 [b] ± 13.527 |
| | Diet containing 2.5% artichoke leaves | 226.66 [f] ± 13.576 | 201.66 [cd] ± 6.027 | 321.00 [c] ± 23.895 |
| | Diet containing 5% artichoke leaves | 343.66 [d] ± 27.319 | 210.66 [bc] ± 3.055 | 315.66 [c] ± 7.505 |
| | Diet containing 2.5% Arabic gum and 2.5% artichoke leaves | 367.00 [c] ± 9.848 | 219.00 [b] ± 7.549 | 330.66 [bc] ± 17.214 |
| | Diet containing 5% Arabic gum and 5% artichoke leaves | 420.33 [b] ± 9.073 | 217.33 [b] ± 6.506 | 343.66 [bc] ± 31.564 |

*BD: Basal diet* *Each value is shown as mean ± standard deviation*
*Mean values in each column with same letters are not significantly different.*
*Significant differences at ($p \leq 0.05$)*

Glycerol-induced acute renal failure in rats decreases antioxidant enzyme levels, indicating a disrupted antioxidant defense due to kidney damage. Reduced GPX, SOD, and catalase levels impair the kidney's ability to combat oxidative stress, leading to increased damage and dysfunction **(Andrades *et al*., 2002; Akçay *et al*., 1997).** This imbalance highlights the role of oxidative stress in exacerbating renal injury.

This study highlights Gum Arabic's potential to enhance antioxidant enzyme activity, including glutathione peroxidase (GPX), superoxide dismutase (SOD), and catalase. Research shows that Gum Arabic, rich in polyphenols and polysaccharides, can boost these enzymes' activity. **Mahmoud *et al*. (2012)** found increased GPX, SOD, and catalase in diabetic rats given Gum Arabic. **Abdel-Aziz *et al*. (2017)** confirmed that Gum Arabic improved these enzymes in rats with arsenic-induced oxidative stress. Further studies by **Aboul-Enein *et al*. (2020)** and **Ali *et al*. (2021)** reported increased GPX and SOD levels, respectively, while **Abdelrazek *et al*. (2019)** noted enhanced catalase activity, underscoring Gum Arabic's antioxidative benefits.

Feeding ARF rats diets with artichoke leaves increased antioxidant enzymes (GPX, SOD, and catalase) compared to healthy rats. Artichoke leaves, rich in cynarin and flavonoids, enhance enzyme activities and reduce oxidative stress. Studies by **Asadi *et al*. (2021); El-Gengaihi *et al*. (2020) and Nabavi *et al*. (2022)** demonstrated that artichoke leaf extract boosts GPX, SOD, and catalase activities, indicating its potential to mitigate oxidative stress.

## Histopathological examination of kidneys:

Microscopic examination revealed normal kidney structure in rats fed a basal diet (control negative group). In contrast, glycerol-injected rats fed on a basal diet (control positive group) showed significant histopathological lesions, including vacuolar degeneration, eosinophilic casts, and blood vessel congestion. Rats on a 2.5% Arabic gum diet had some vacuolar degeneration and vessel congestion, while those on a 5% Arabic gum diet showed both inflammation and normal tissue in different sections. Rats on 2.5% or 5% artichoke leaves diets generally had no lesions, except for minor vacuolar degeneration in some 5% artichoke leaves sections. Rats fed a 2.5% Arabic gum and 2.5% artichoke leaves combination had minor vessel dilation and congestion, but those on a 5% Arabic gum and 5% artichoke leaves combination showed mostly normal kidney tissue with only slight vacuolar degeneration in a few areas.

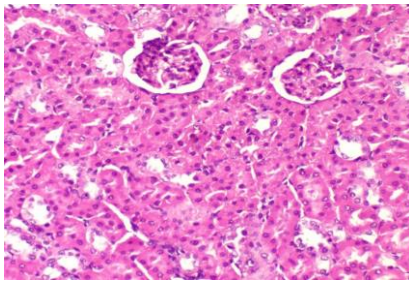

**Fig. (1): Photomicrograph of kidney of rat from control negative group fed on basal diet showing normal histological structure of renal parenchyma (H & E X 400).**

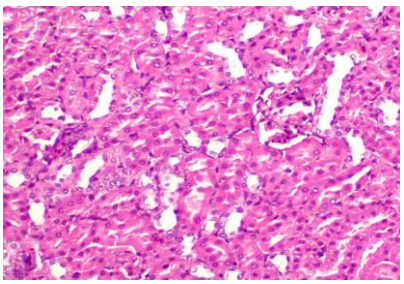

**Fig. (2): Photomicrograph of kidney of rat from control negative group fed on basal diet showing normal histological structure of renal parenchyma (H & E X 400).**

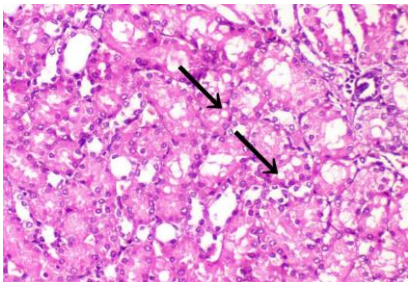

**Fig. (3): Photomicrograph of kidney of rat from control positive group fed on basal diet showing vacuolar degeneration of epithelial lining renal tubules (black arrow) (H & E X 400).**

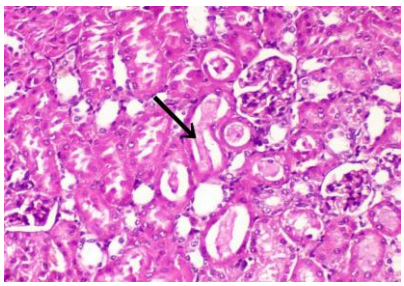

**Fig. (4): Photomicrograph of kidney of rat from control positive group fed on basal diet showing eosinophilic proteinaceous casts in the lumen of renal tubules (black arrow) (H & E X 400).**

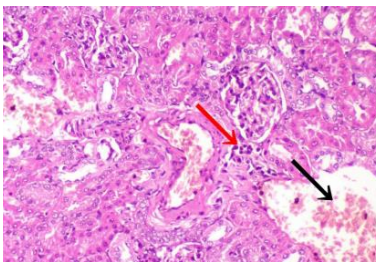

**Fig. (5): Photomicrograph of kidney of rat from control positive group fed on basal diet showing congestion of renal blood vessels (black arrow) and perivascular inflammatory cells infiltration (red arrow) (H & E X 400).**

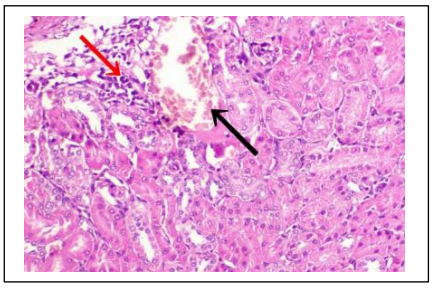

**Fig. (6): Photomicrograph of kidney of rat from control positive group fed on basal diet showing congestion of renal blood vessels (black arrow) and perivascular inflammatory cells infiltration (red arrow) (H & E X 400).**

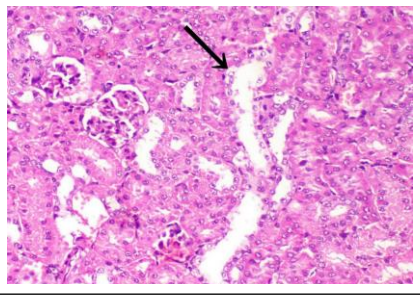

**Fig. (7): Photomicrograph of kidney of rats injected with glycerol and fed a diet containing 2.5% Arabic gum showing vacuolar degeneration of epithelial lining some renal tubules (black arrow) (H & E X 400).**

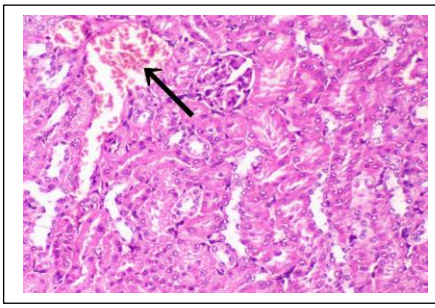

**Fig. (8): Photomicrograph of kidney of rats injected with glycerol and fed a diet containing 2.5% Arabic gum showing congestion of renal blood vessels (black arrow) (H & E X 400).**

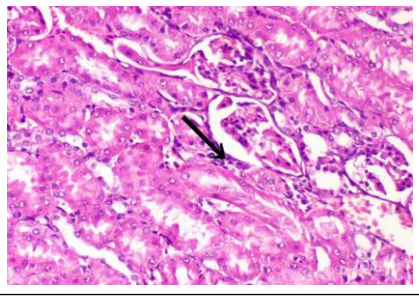

**Fig. (9): Photomicrograph of kidney of rats injected with glycerol and fed a diet containing 5% Arabic gum showing periglomerular inflammatory cells infiltration (black arrow) (H & E X 400).**

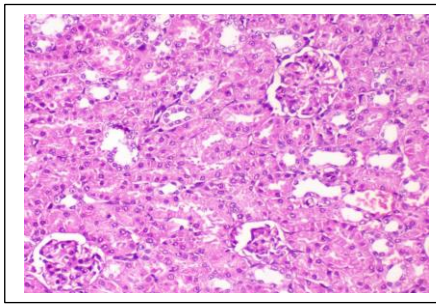

**Fig. (10): Photomicrograph of kidney of rats injected with glycerol and fed a diet containing 5% Arabic gum showing apparent normal renal tissue (H & E X 400).**

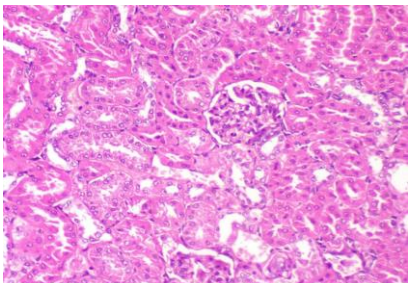

**Fig. (11): Photomicrograph of kidney of rats injected with glycerol and fed a diet containing 2.5% artichoke leaves showing no histopathological lesions (H & E X 400).**

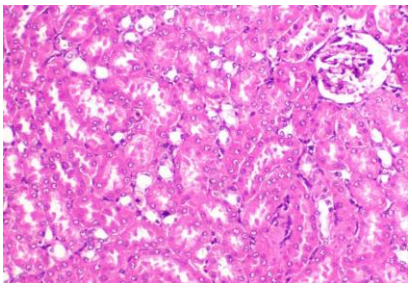

**Fig. (12): Photomicrograph of kidney of rats injected with glycerol and fed a diet containing 2.5% artichoke leaves showing no histopathological lesions (H & E X 400).**

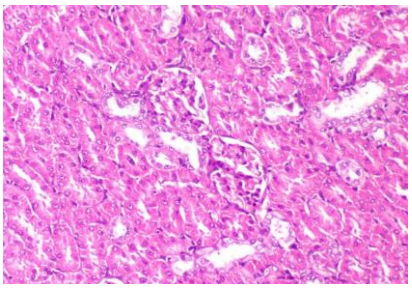

**Fig. (13): Photomicrograph of kidney of rats injected with glycerol and fed a diet containing 5% artichoke leaves showing no histopathological lesions (H & E X 400).**

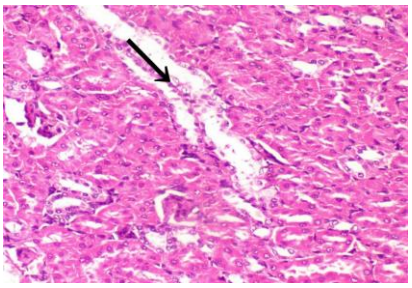

**Fig. (14): Photomicrograph of kidney of rats injected with glycerol and fed a diet containing 5% artichoke leaves showing vacuolar degeneration of epithelial lining some renal tubules (black arrow) (H & E X 400).**

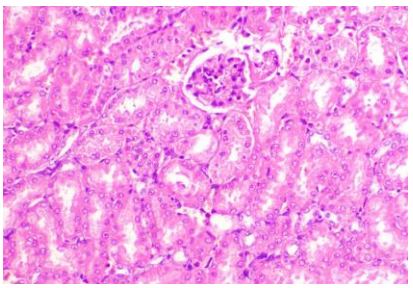

**Fig. (15): Photomicrograph of kidney of rats injected with glycerol and fed a diet containing a combination of 2.5% Arabic gum and 2.5% artichoke leaves showing no histopathological alterations (H & E X 400).**

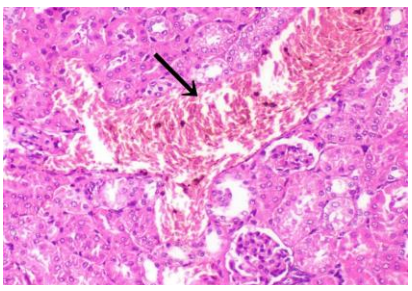

**Fig. (16): Photomicrograph of kidney of rats injected with glycerol and fed a diet containing a combination of 2.5% Arabic gum and 2.5% artichoke leaves showing dilatation and congestion of renal blood vessel (H & E X 400).**

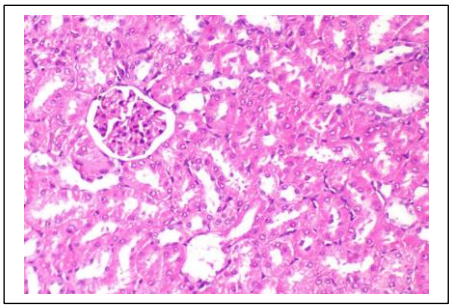

**Fig. (17): Photomicrograph of kidney of rats injected with glycerol and fed a diet containing a combination of 5% Arabic gum and 5% artichoke leaves showing no histopathological alterations (H & E X 400).**

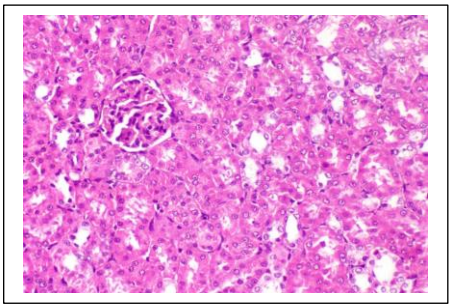

**Fig. (18): Photomicrograph of kidney of rats injected with glycerol and fed a diet containing a combination of 5% Arabic gum and 5% artichoke leaves showing no histopathological alterations (H & E X 400).**

***Sensory Evaluation of Crepes Enriched with Varying Levels of Arabic Gum (AG), Artichoke Leaves (AL), and Their Combinations.***

The data in Table (8) show that the average score ± SD for the characteristics of the control crepe sample were as follows: color 19.30 ± 0.67, odor 19.60 ± 0.51, taste 19.50 ± 0.55, general acceptability 19.60 ± 0.51, and total score 97.10 ± 2.37.

Statistical analysis revealed significant differences. The mean value ± SD for color, odor, texture, taste, general acceptability, and total score in crepes fortified with 2.5% Arabic gum, 5% Arabic gum, 2.5% artichoke leaves, 5% artichoke leaves, 2.5% Arabic gum + 2.5% artichoke leaves, and 5% Arabic gum + 5% artichoke leaves showed a significant decrease ($p \leq 0.05$) compared to the control sample. Exceptions were observed in texture for crepes fortified with 2.5% Arabic gum and 2.5% artichoke leaves, and in taste for crepes fortified with 2.5% Arabic gum and 5% Arabic gum.

The table reveals a significant decrease in color, taste, and total score of crepes fortified with 2.5% and 5% artichoke leaves compared to those fortified with Arabic gum. The table indicates that the best sensory evaluations were observed in crepe samples fortified with 2.5% Arabic gum, 5% Arabic gum, and a combination of 2.5% Arabic gum and 2.5% artichoke leaves.

***Benefits of fortification with gum Arabic and artichoke leaves.*** Crepes can be fortified with Arabic gum and artichoke leaves to improve their nutritional value and health. Artichoke leaves, rich in antioxidant and anti-inflammatory properties, can combat oxidative stress and reduce inflammation. Arabic gum promotes gut bacteria growth, while artichoke leaves support liver function and bile production. The combination enhances crepes' texture and

flavor, making them more appealing to health-conscious consumers. Recent studies highlight the potential synergistic effects of these ingredients in food fortification strategies.

**Table (8): Sensory evaluation of crepes enriched with varying levels of Arabic Gum (AG), Artichoke Leaves (AL), and their combinations.**

| Characteristics / Treatments | Color (20) | Odor (20) | Texture (20) | Taste (20) | General acceptable (20) | Total Score (100) |
|---|---|---|---|---|---|---|
| **Control** | 19.30 ± 0.67 $^{a}$ | 19.60 ± 0.51 $^{a}$ | 19.50 ± 0.55$^{a}$ | 19.60 ± 0.51$^{a}$ | 19.50 ± 0.55$^{a}$ | 97.50 ± 2.37$^{a}$ |
| **2.5% AG** | 18.75 ± 2.07 $^{b}$ | 18.60 ± 2.22 $^{b}$ | 19.05 ± 2.98$^{ab}$ | 19.30 ± 0.67 $^{a}$ | 18.60 ± 2.50$^{b}$ | 94.28 ± 12.06$^{b}$ |
| **5 % AG** | 18.20 ± 2.78$^{b}$ | 18.42 ±3.11$^{b}$ | 18.75 ± 2.07 $^{b}$ | 19.05 ±2.98$^{ab}$ | 18.60 ± 3.57$^{b}$ | 92.72 ± 11.32$^{b}$ |
| **2.5% AL** | 17.90 ± 3.03$^{c}$ | 18.35 ± 3.44 $^{b}$ | 19.05 ±2.98$^{ab}$ | 18.65 ±2.80$^{b}$ | 18.35 ± 3.44$^{b}$ | 92.3 ±12.85$^{c}$ |
| **5% AL** | 17.20 ± 3.35 $^{c}$ | 18.20 ± 2.44 $^{b}$ | 18.42 ±3.11$^{b}$ | 18.20 ±2.44 $^{b}$ | 18.20 ±2.44$^{b}$ | 90.22 ± 17.70$^{c}$ |
| **2.5%AG + 2.5%AL** | 18.07 ± 2.60$^{bc}$ | 18.35 ± 3.44 $^{b}$ | 17.94 ±2.89$^{c}$ | 17.40 ±3.65$^{c}$ | 18.75 ± 2.07$^{b}$ | 90.52 ±10.51$^{bc}$ |
| **5%AG + 5% AL** | 17.05 ± 2.60$^{bc}$ | 17.94 ±2.89$^{c}$ | 17.80 ±4.02$^{c}$ | 17.20 ± 3.35 $^{c}$ | 17.90 ± 3.90$^{c}$ | 87.89 ±15.69 $^{c}$ |

*Each value is shown as mean ± standard deviation AG: Arabic gum AL: Artichoke Leaves*
*Mean values in each column with same letters are not significantly different.*
*Significant differences at ($p \leq 0.05$)*

## CONCLUSION:

In conclusion, the study demonstrated that Arabic gum, artichoke leaves, and their combination had a positive effect on rats with renal failure. These treatments improved body weight, serum protein, and antioxidant enzyme levels while reducing kidney and liver dysfunction markers. The combination of both treatments, at both high and low concentrations, yielded the best results. Histopathological analysis further supported these improvements. Additionally, crepes prepared with different concentrations of Arabic gum and artichoke leaves were well-received in sensory evaluations, confirming their palatability.

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# تأثير الصمغ العربي و أوراق الخرشوف علي الفئران المصابة بالفشل الكلوي

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**المستخلص :**

أجريت هذه الدراسة لتقييم تأثير الصمغ العربي و أوراق الخرشوف وخليطهما على فئران التجارب المصابة بالفشل الكلوي. تم تقسيم الفئران إلى مجموعات، حيث تلقت تركيزات مختلفة من الصمغ العربي وأوراق الخرشوف وخليطهما في نظامها الغذائي . أظهرت النتائج أن احداث الفشل الكلوي بالجليسيرول تسبب في انخفاض في وزن الجسم ومستويات مصل كل من البروتين والإنزيمات المضادة للأكسدة، مع حدوث ارتفاع في مؤشرات وظائف الكلى والكبد. أدت معاملة الفئران المصابة بالفشل الكلوي، بالصمغ العربي وأوراق الخرشوف وخليطهما إلى تحسين هذه المؤشرات، ولوحظ ان أفضل النتائج سجلت في الفئران التي تناولت مستويات عالية ومنخفضة من خليط الصمغ العربي واوراق الخرشوف .وقد دعم التحليل النسيجي للكلي هذه النتائج، مما يشير إلى أن الصمغ العربي وأوراق الخرشوف يساعدان في تخفيف أعراض الفشل الكلوي .وفي نهاية التجربة البيولوجية، تم تحضير سبع عينات من الكريب، تحتوي على ٢,٥٪ و ٥٪ من الصمغ العربي، و ٢,٥٪ و ٥٪ من أوراق الخرشوف، وخليط من ٢,٥٪ و ٥٪ من الصمغ العربي واوراق الخرشوف، ووجد أن جميع المعاملات كانت مقبولة في التقييم الحسي.

**الكلمات المفتاحية : الفشل الكلوي، الصمغ العربي، أوراق الخرشوف، التحاليل الحيوية ،الفحص النسيجي.**