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The Effect of Gum Arabic (Liquid/Solid State)Feeding on Acute Kidney Injuries in Rats

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Abstract

Many studies checked theGum Arabic (GA) effects on retarded kidney functions, but there is a dearth of information regarding what the shape that could be more efficient for human? Therefore, the present study conducted to investigate and compare the effect ofGA intakes as liquid or powder shape feeding on rats suffered from acute kidney injury (AKI) or nephrotoxicty induced by gentamicin (GM). Thirty two adult male albino rats weighing about 150 ± 10g were divided into two main groups; the first, negative control (C-), was eight normal rats fed on basal diet, while the second (n =24 rats) were injected intraperitoneal (i.p.) with GM in a dose of 80 mg/kg b. wt./day for 8 consecutive days to induce AKI. After lesion confirmation, rats were divided into three sub-groups (8 rats /each) and fed on basal diet only (positive control C+group), or with GA colloidal solution (10%) administered orally (20 ml/kg body weight), or with 2% GA supplementation of total diet weight as powder for 28 consecutive days. **Results** showed that GM injection elevated significantly ($p<0.05$) the levels of uric acid, urea, createnine, AST&ALT activity,TC andLDL-c in serum, also MDA and NO levels in kidney tissues. While decreased significantly ($p<0.05$) the potassium, sodium, total proteins, albumin, globulin in serum and SOD levels in kidney tissues compared with C- group. Nutritional intervention with GA ameliorated significantly all theseparameters and restored the normal structure of kidney cells,whereas no significant differences between the two shapes used were reported for the effectiveness on all parameters assessed. In **conclusion**, nutritional supplementation with GA as a liquid (10%) or powder (2%) ameliorated significantly the accompanied symptoms of AKI, without any significant difference for the effectiveness of the shape used.

Key wards: Gum Arabic, Kidney functions, Liver enzymes, Electrolytes, Lipid profile, SOD, MDA and NO level.

Introduction

Main function of the kidney is maintaining the fluid, electrolyte and pH balance of the body as filtering ions, macromolecules, water and nitrogenous wastes from the blood according to the body's condition. Blockage of the drainage system can cause the kidney to become congested, stretched, and potentially scarred. Functioning kidneys are necessary to maintain life, and one measure of their function is the glomerular filtration rate **(Medline, 2012)**. A loss of kidney function results in the need for dialysis, which is an artificial method for removing wastes from the blood by running it from the body through an artificial kidney, and then back into the body **(Alicia, 2009)**.

Renal failure, also known as renal insufficiency; is a medical condition in which the kidneys fail to adequately filter waste products from the blood. The two main forms are acute kidney injury; which is often reversible with adequate treatments, and chronic renal failure (CRF); which is often not reversible **(Taketomo*et al.*, 2011)**. Renal failure is mainly determined by a decrement in glomerular filtration rate at which blood is filtered in the glomeruli of the kidney, which accompanied with a decrease in or absence of urine production or elevations for waste products levels (creatinine or urea) in the blood. Depending on the cause, hematuria (blood loss in the urine) and proteinuria (protein loss in the urine) could be recorded **(Medline, 2012)**.

The initial symptoms of nephrotoxicity may be due to renal tubular concentrating defect; these include excessive losses of sodium, calcium and magnesium, which may progress to proteinuria, casts, increased blood urea nitrogen, oliguria and increased serum creatinine. Renal impairment is most often reversible **(Taketomo*et al.*, 2011)**, while chronic kidney disease is a morbid condition that increases the chances of heart as well as renal failure and other complications. A number of drugs, chemical substances, xenobiotics, heavy metals and oxidative stresses are known to affect the kidneys **(Navab*et al.*, 2011)** by altering its structure, function and further leads to nephropathies **(Barbier*et al.*, 2005)**.Gentamicin (GM) is one of these drugs; an antibiotic used to treat many types of bacterial infections, it is also toxic and nephrotoxic **(Moulds and Jeyasingham, 2010)**. Like other aminoglycosides, GM causes nephrotoxicity by inhibiting protein synthesis in renal cells. This mechanism specifically causes necrosis for cells in the proximal tubule, resulting in acute tubular necrosis, which could lead to acute renal failure **(Sundin*et al.*, 2001)**. Nephrotoxicity caused by GM seemed to be attributed to the oxidative stress caused by generation of reactive oxygen species **(Tavafi*et al.*, 2012)**.

The cost of treating uremia represents a growing demand on the health care systems of both rich developed and developing countries. The literature is replete with publications on the impact of the nutrition on kidney disease **(Lacson*et al.*, 2007)**. Most dietary attempts to treat chronic renal failure and to decrease uremia were using a protein restriction regimen **(Chaturvedi and Jones, 2007)**. An alternative dietetic approach has relatively recently been proposed, based on fermentable carbohydrate supplementation of the diet **(Winchester and Salsburgh, 2004)**. This has been claimed to result in a similar urea-lowering effect by increasing urea nitrogen (N) excretion in stools, with a concomitant decrease in the total N excreted in urine of adults **(Ali *et al.*, 2008)**.In this regard,**Bliss *et al.*, (1996)** reported that addition of Gum Arabic to the diet has been shown to increase fecal nitrogen excretion and decrease serum urea nitrogen concentration in patients with chronic kidney disease, and this was shown to be dependent on increased bacterial growth and activity in the gut.

The named Gum Arabic(GA)or gum Acacia (AG) is edible, dried, gummy exudates from the stems and branches of *Acacia senegal*or*Acacia seyal* (leguminous) that is rich in non-viscous soluble fiber **(Abdul-Hadi*et al.*, 2010**). Gum is essentially the secretion of several acacia trees; there are up to seventeen species of GA produce varying in the quality and quantity, 80% of Gum Arabic is produced in Sudan,also it found in Oman, Pakistan and India. GA is commonly used in the pharmaceutical and food industries as emulsifier and stabilizer as suspending agent for insoluble drugs **(Lelon*et al.*, 2010).** Also,it has long been used in Arab folk medicine to reduce both the frequency and the need for hemo-dialysis in patients with chronic renal failure. Additionally, GA has been shown to reduce urinary nitrogen excretion by increasing urea disposal in the cecum and lowers serum urea concentration in rats and human **(Bliss *et al.*, 1996)**. Some studies have highlighted; GA antioxidant properties **(Ali and Al Moundhri, 2006)**, its role in the metabolism of lipids **(Tiss*et al.*, 2001)**, its positive results in several degenerative diseases treatment such as kidney failure **(Matsumoto *et al.*, 2006 and Ali *et al.*, 2008)** and cardiovascular failure **(Glover *et al.*, 2009)**.

Regarding the effect of GA on kidney diseases, **Ali *et al.*, (2008)** assessed in Sudan the GAeffectiveness on the concentrations of certain metabolites in the sera of patients with CRF on a low-protein diet, they reported that serum creatinine, urea, phosphate and uric acid concentrations were significantly reduced, while significantly increased serum calcium. GA ameliorates adenine-induced CRF in rats may include anti-oxidant and anti-inflammatory actions. It has been reported that treatment with GA in healthy mice resulted in moderate, but

significant, increases for creatinine clearance and altered electrolyte excretion, suggesting favorable actions for renal insufficiency **(Nasir*et al.*, 2008)**.

The present study was conducted to investigate and compare the effect of GA as a liquid or powder feeding on rats suffered from acute kidney injury or nephrotoxicty induced by GM.

Material and methods

Materials

Casein (85% protein), vitamins mixture, salt mixture, corn starch, DL-methionine, choline chloride, cellulose, GA "*Acacia Senegal* L." were purchased from El-Gomhoria Company for Chemicals, Drugs and Medicals supplies, Cairo, Egypt.

GM (Gentamicin), an amino glycoside antibiotic, was obtained from Memphis Company for Pharmaceutical and Chemical Industries, at local pharmacy in Cairo, Egypt, as ampoules containing 40 mg/mL of gentamicin sulphate/ each ambule.

Gum acacia is nearly entirely soluble in water and insoluble in alcohol and most other organic solvents. Its remarkable solubility in water allows for the preparation of highly concentrated solutions. The liquid state checked as 10% colloidal solution (CS), which prepared freshly by warming distilled water and suspending the Gum Arabic powder as 9 ml water: 1g GA, then kept it at room temperature, CS was given to the animals orally by stomach tube. Solid state was checked by adding GA as powder to the basal diet as 2% dose of total diet weight.

Methods

Experimental design:

Thirty two healthy adult male albino rats (*Sprague Dawley*Strain) with body weight about 150 ±10g were obtained from National Research Center, Dokki, Egypt, and kept in wire cages. Animals were adapted to the laboratory conditions for one week before feeding intervention. Rats were fed on standard diet according to **Reeves *et al.*, (1993)** contained the essential vitamins mixture according to **Campbell,** (**1963)** and minerals mixture to **Hegsted*et al.***, (**1941)**.

Rats were divided into two main groups; first (8rats) was negative control group (C-) and fed on basal diet, while the second main group was injected intraperitoneal (i.p.) with GM in a dose 80 mg/kg b. wt. /day in 0.9% saline for 8 consecutive days to induce (AKI) and nephrotoxicity according to the method described by **Bibu*et al.*, (2010)**.Aftereight days acute kidney injury was confirmed (serum uric acid, urea nitrogen and createnine elevations), then rats were divided into three subgroups (8 rats / each) as follows; first subgroup was

positive control (C+) and fed on basal diet only, while second and third subgroups were treatment groups fed on basal diet with Gum Arabic as 10% CS administered orally (20mlL. / kg b. wt.), or with GA as powder (2% of total diet weight). Diet introduced as 10% of rats body weight with water supply *ad-libitum* and checked daily.

At the end of experimental period (28days), all rats were fasted over nightand sacrificed under ether anesthetized, and then blood samples were collected from hepatic portal vein and centrifuged to separate the serum and kept frozen at -20 ˚C till analysis. Kidneys were put in 10% formalin solution for histopathological examination after washing in saline solution.

Approximate chemical composition of GA

Moisture, fat, crude fibers, total protein and ash content were analyzed according to **A.O.A.C. (2000),** whilecarbohydratewas calculated by the difference.

Biochemical analysis:

Serum uric acid,urea nitrogen, createnine and electrolytes (sodium and potassium) were determined as kidney function indicators according to**Fossati *et al*., (1980), Patton and Crouch (1977), Murray *et al*., (1984)** and **Henry, (1974)** respectively. Serum aspartate aminotransferase (AST) and alanine aminotransferase (ALT) as liver enzymes indicators were estimated according to **Reitman and Frankel, (1957).** Serumtotal protein and albumin were assessed according to**Sonnenwirth&Jaret (1980)** and**Drupt, (1974)** respectively. Globulin was calculated according to **Chary and Sharma, (2004).**

Serum total cholesterol, triglycerides, HDL-cwere determined according to**Allain*et al*., (1974), Trinder and Ann, (1969),** and**Lopes - Virella*et al*., (1977)** respectively,while LDL-c and VLDL-c were calculated according to**Friedwald*et al*., (1972).** Determination of Superoxide dismutase (SOD),malondialdehyde (MDA) and nitric oxide (NO) in Kidney's tissue were done according to**Winterbourn*et al*., (1975),Ohkawa*et al*., (1979)** and **Green *et al*., (1982),** respectively**.**

Histopathologicalexamination was done for the sections at 4-6 microns thickness of washed kidneys, and stained with Heamtoxylin and Eosin according to **Carleton, (1979).**

Statistical analysis:

Data were expressed as Mean ±SD. Differences between control and treated groups were tested for significance using one way analysis of

variance (ANOVA test)and differences were considered significant at level of P < 0.05 using **SPSS** program Ver. **2014** according to **Steel and Torri, (1980)**,followed by Duncan's multiple range test computerized program **(Duncan, 1957)**.

Results and Discussion

Approximate chemical composition of GA

Major chemical contents in100 gm of Gum Arabic powder used showed in Table (1) that protein, fat, moisture and ash contents were 2.68, 0.21, 13.13 and 3.12% respectively, while fiber and carbohydrate content were 80.86%, which indicates the highest component in Gum Arabic.

Table (1): Chemical contents ofGA (g/100 g)

Protein	Fat	Moisture	Ash	Fiber&Carbohydrate
2.68±0.41	**0.21**±0.032	**13.13**±1.72	**3.12**±4.62	**80.86**±10.53

Kidney functions indicators:

Data presented in table (2) showed significant increments ($p<0.05$) in mean values of serum uric acid, urea and createnine after intraperitoneal (i.p.) GM injection, as reflected in positive control group comparing with negative one. Treating the intervention groups with Gum Arabic (colloidal solution and powder shapes) ameliorated significantly these elevated values comparing with C+ group. According to the values not significances, powder shape was more effective in urea and createnine ameliorations than CS feeding, while CS was more effective than powder shape feeding in uric acid amelioration, but no significant differences were reported for the effectiveness of the two shapes used.

Results about gentamicin injection are in agreement with **Taketomo*et al.*, (2011)**, who found that nephrotoxicity associated with excessive accumulation of gentamicin induced renal tubular concentrating defect, which may progress protein, urea and createnine elevations. Also with **El Badwi*et al.*, (2012),** whoconfirmed these findings, when reported thatgentamicin injection to rats resulted in significant elevations for serum uric acid, urea nitrogen and creatinine values. Furthermore, **Alqasoumi**, **(2013)** and **Ramhariya*et al.*, (2014)** outcomes were within with these results mentioned above.

While about Gum Arabic treatment, present outcomes are in agreement with **Al-Majed*et al.*, (2002), (2003),** who reported that GA

exhibited a protective effect against gentamicin or cisplatin-nephrotoxicity. Also, with **Ali *et al.*, (2008),** who reported that GA administered orally, at dose of 50 g/day for 3 months, to patients with chronic renal failure under low-protein diet decreased significantly serum creatinine, urea, phosphate and uric acid concentrations.As elucidation**Ali *et al.*,** mentioned at **(2010)** that colonic bacteria produce ureases, which hydrolyze urea to ammonia and carbon dioxide. The resultant ammonia can then be incorporated into bacterial proteins and subsequently excreted in the bacterial mass fraction with the feces, which resulted in increment in nitrogen excretion at the feces.

The results of the present study are in agreement also with a similar study by **Alubaidy, (2013),** who reported that treatment with GA (10gm/kg b.wt,/day) significantly decreased the elevated levels of serum creatinine, uric acid, urea and total bilirubin in gentamicin-induced AKI rats comparing with control group. Also agree with **Gado andAldahmash, (2013)** who indicated that GA improved Hg-induced nephrotoxicity, confirmed by a decrease in both serum creatinine and urea levels, and minimized the intensity of the renal lesions.

Table (2): Means ±SD **of serum uric acid, urea nitrogen and creatinine for rats in controls and GA treated groups**

Group	Uric Acid (mg/dl)	Urea (mg/dl)	Creatinine (mg/dl)
Control (C-)	**1.53^{d}**± 0.24	**45.22^{b}**± 5.81	**1.11 ^{d}**±0.20
Control (C+)	**2.05^{a}**± 0.32	**58.02^{a}**± 8.76	**2.25 ^{a}**±0.18
Gum Arabic (Solution feeding)	**1.63^{cd}**± 0.21	**42.04^{b}**± 5.84	**1.25^{cd}**±0.17
Gum Arabic (Powder feeding)	**1.66^{cd}**± 0.23	**39.37^{b}**± 6.21	**1.13 ^{d}**±0.14

- Values which have different letters in the same column differed significantly at $p < 0.05$

Data in Table (3) exhibited that inducing renal injuries by gentamicin injection decreased significantly ($P<0.05$) the levels of sodium and potassium in blood of rats comparing with C- group. While GA nutritional intervention, both shapes, elevated significantly ($P<0.05$) the potassium levels comparing with positive control one. Whereas, GA in powder shape only was effective in ameliorating significantly the reported reduction than colloidal solution for potassium level comparing with C+ group. No significant difference was found between the two shapes used regarding sodium & potassium amelioration.

Table (3): Means ±SD **of serum sodium and potassium for rats in**

controls and AG treated groups.

Groups	Sodium mg/dL	Potassium mg/dL
Control (C-)	**152.63**[a]±25.7	**4.56**[a]± 0.74
Control (C+)	**143.13**[c]± 19.2	**3.54**[c]± 0.53
Gum Arabic (Solution feeding)	**147.96**[abc]± 23.4	**4.12**[b]± 0.68
Gum Arabic (Powder feeding)	**149.11**[ab]± 28.3	**4.14**[b]± 0.59

- Values which have different letters in the same column differed significantly at $p < 0.05$.

The present study's outcomes are in agreement with **Elgazar and Abo Raya, (2013)** and**Shalaby&Hammouda, (2014),** who documented that daily GM intra-peritoneal injection to rats for consecutive 8 days caused significant decrements in serum levels of sodium and potassium electrolytes comparing with normal rats.The mechanism of nephrotoxicity caused by GM could attribute to stimulation of reactive oxygen species generation causing tissue oxidative stresses (**Tavafi*et al.*, 2012**). GM-nephrotoxicity associated with decreases in serum levels of sodium and potassium suggested that the site of GM action is the distal convoluted tubules, which increased urinary excretion of sodium and potassium **(Elliott *et al.*, 2000).**

Liver function indicators:

Liver is the chief organ involved in detoxifying body, when it's over-stressed all other organs start to dysfunction **(Campbell *et al.*, 2008).**Serum enzymes including AST and ALT are used in the evaluation of hepatic disorders; any increase in these enzymes activity reflected an active liver damage **(Mansour *et al.*, 2002)**.

Means of control groups in Table (4), documented that oxidative stresses may be generate by GM injection increased significantly ($P<0.05$) ALT and AST enzymes activity, which reflects liver functions distortion. Whereas, intervention with GA in both shapes cured significantly the rising of AST enzyme activity until reach the level of C- group. While, only colloidal solution of GA feeding was effective in the curing of AST enzyme activity comparing with C+ group. No significant difference was noted between the two shapes feeding regarding the effectiveness on ALT & AST activity.

Table (4): Means ±SD **of serum ALT andASTfor rats in controls and AG treated groups**.

Group	ALT (U/L)	AST (U/L)
Control (C-)	**27.37** ^{c}± 4.23	**47.13**^{b}± 8.02
Control (C+)	**43.93**^{a}± 9.12	**67.14**^{a}± 12.84
Gum Arabic (Solution feeding)	**24.79**^{c}± 3.72	**43.32**^{b}± 6.22
Gum Arabic (Powder feeding)	**34.95**^{abc}± 6.24	**41.14**^{b}± 7.14

- Values which have different letters in the same column differed significantly at $p < 0.05$.

These changes of GM injection for liver enzymes were in consistent with **Al-Kenanny*et al.*, (2012)** in similar study, who reported a progressive increment in serum enzymes specially ALT and AST. They elucidated that gentamicin consistently produced nephrotoxicity, but indirectly by hepato-renal syndrome gentamicin can produce hepatotoxicity. Also, in agreement with the present work, they documented that orally administration of GA to mice, 10gm /kg/for eight days, showed antioxidant capacity as a significant amelioration for hepatotoxicity by increasing GSH, decreasing MDA levels in addition to improving the enzymatic levels of ALT and AST in serum of mice. Also results of GA intervention are in agreement with a study by **Alubaidy, (2013)**, who reported that administration of GA (10gm/kg b.wt./day) alone significantly reduced the elevated levels of AST, ALT and ALP in serum as compared to the gentamicin treated group.

Regarding proteins; several important proteins produced in liver, albumin is one of these productions and play important roles in retaining calcium and other substances, also regulates the water movement between blood stream and tissues **(Campbell *et al.*, 2008).** Results compiled in Table (5) showed that artificial oxidative stresses may be induced by GM injection retarded proteins production in liver then consequently in serum, and that illustrated within comparing the control groups. C+ group reflected significant reduction in serum total proteins, consequently albumin and globulin also comparing with C- group. Nutritional intervention groups withGum Arabic, in both shapes, recorded significant increments ($p<0.05$) for the decreased total proteins and accordingly for albumin & globulin comparing with C+ group. Also, no significant difference was noted between powder and solutionGA feeding effectiveness in proteins amelioration.

Table (5): Means ±SD of total proteins, albumin and globulin for rats in controls and AG treated groups.

Group	T.P mg/ dl	Alb. mg/ dl	Glb. mg/ dl
Control (C-)	**7.32**[a]± 1.24	**4.48**[a]± 0.73	**2.84**[a]
Control (C+)	**5.57**[c]± 0.83	**3.93**[b]± 0.62	**1.64**[b]
Gum Arabic (Solution feeding)	**7.29**[a]± 1.02	**4.58**[a]± 0.81	**2.71**[a]
Gum Arabic (Powder feeding)	**7.39**[a]± 1.37	**4.58**[a]± 0.66	**2.81**[a]

- Values which have different letters in the same column differed significantly at $p < 0.05$.

These results agreed with **Alqasoumi, (2013),** who found that GM caused renal oxidative stress assured by the depletion of TP in kidney tissue. Also, results are in agreement with **Gado and Aldahmash, (2013)** who indicated that anti-oxidation induced by GA feeding, might be one of the most likely mechanisms contributing to its beneficial effect against renal injury. They mentioned that this antioxidant effect of GA was confirmed previously by *in vitro* studies, which showed that GA had a dose-dependent scavenging for superoxide radicals generated enzymatically and non-enzymatically. Also, **Rehman*et al*, (2001)** suggested that GA may find clinical application in a variety of condition where cellular damage is a consequence of oxidative stress.

Serum lipid profile:

Investigation for the means presented in Table (6) revealed that GM i.p. injection increased significantly ($P<0.05$) the total cholesterols and insignificantly the triglycerides in rats serum comparing with C- group. Meanwhile, GA supplementations in both shapes ameliorated significantly ($P<0.05$) the documented rising for total cholesterols in these groups comparing with C+ group. Powder shape was more effective in lowering total cholesterol elevation than solution shape, whereas GA as liquid state supplementation cured significantly ($P<0.05$) the elevation of triglycerides, while powder state effect was insignificant. GA solution was more effective in lowering triglycerides than powder shape. Although all differences mentioned for powder and solution shape in the effectiveness of them, but no significant difference was reported between them.

Various mechanisms have been proposed in explaining the

hypocholesterolemic effect of GA, some studies have suggested that the viscosity of fermentable dietary fiber contributes substantially to the reduction of lipids in animals and humans. The mechanism involved is clearly linked to increased bile acid excretion and fecal neutral sterol or a modification of digestion and absorption of lipids **Tiss*et al.*, (2001)**.

Table (6): Means ±SD **of serum total cholesterols and triglycerides for rats in controls and AG treated groups.**

Group	Total cholesterols (mg/dL)	Triglycerides (mg/dL)
Control (C-)	**81.29**^{b} ± 9.22	**77.21**^{abc}± 13.21
Control (C+)	**100.19**^{a}± 12.16	**86.88**^{a}± 9.14
Gum Arabic (Solution feeding)	**84.19**^{b}± 10.09	**73.05**^{c}± 7.46
Gum Arabic (Powder feeding)	**81.39**^{b}± 8.96	**80.71**^{abc}± 11.31

- Values which have different letters in the same column differed significantly at $p < 0.05$.

The results of the present study are in parallel with that documented by **Abd-Razig*et al*, (2010)** about lowering triacylglycerol by GA. Also agree with **Sabahelkhier*et al.*, (2013),** who studied the effect of different types of Gum Arabic *A. Senegal* (Hashab), *A. seyal*(Talha), *A. polyacantha*(Kakmut), and *Cyamopsistetragonoloba*(Guar gum) on blood glucose, total protein, lipid profile and body weight. They reported that supplementation with 5 % GA significantly (P< 0.05) lowered the cholesterol level for Hashab and Talha types, while no change noticed for cholesterol level in Kakmut type.Also, **James *et al.*, (2014)** reported that Gum Arabic feeding as 5% of total diets significantly decreased the absorption of dietary cholesterol by 17%.

According to the fractions of cholesterols, it's cleared in Table (7) that GM injection for rats affected the serum lipid profile; insignificantly high density lipoprotein cholesterol (HDL-c) level was decreased, whereas very low density lipoprotein cholesterol (VLDL-c) was increased, while low density lipoprotein cholesterol (LDL-c) increased significantly (P<0.05) after the injection. Treatment the intervention groups with GA in both shapes developed the HDL-c level in serum but with no significance, also VLDL-c with powder shape was, while ameliorated significantly the elevated levels of; LDL-c in serum

with both shapes used and VLDL-c for solution shape only comparing with the positive control group. No significant difference was noted between the two studied shapes in the serum lipid profile of intervention groups.

Table (7): Means ±SD **of serum cholesterols fractions for rats in controls and AG treated groups.**

Group	HDL-c mg/ dL	LDL-c mg/ dL	VLDL-c mg/ dL
Control (C-)	**42.10**[a] ± 7.20	**23.75**[d]	**15.44** [abc]
Control (C+)	**34.81**[a] ± 5.93	**48.00**[a]	**17.38** [a]
Gum Arabic (Solution feeding)	**37.00** [a] ± 6.69	**32.58** [bcd]	**14.61** [c]
Gum Arabic (Powder feeding)	**36.17**[a] ± 7.92	**29.08** [cd]	**16.14** [abc]

- Values which have different letters in the same column differed significantly at $p < 0.05$.

In agreement, **Sharma, (1985)** observed reduction for total serum cholesterol in harmony with the doses used (25 & 30 g/day) of GA for periods of 21 and 30 days. The decrease was confined to LDL-c and VLDL-c only, with no effect on HDL-c and triglycerides. Further agreements, results of this study is partially agree with **Sabahelkhier*et al.*, (2013),** who found improvement in lipid profile with 5% of GA in different kinds supplementations; HDL was increased with "Hashab", "Talha" and "Kakmut" but it is not affected by "Guar". LDL-c was decreased by "Talha" and increased by "Hashab", but not affected by "Kakmut". Also, some studies have highlighted GA antioxidant properties **Ali and Al Moundhri, (2006)** and its role in the metabolism of lipids **Tiss*et al.*, (2001).**

Oxidant \ Antioxidant status:

No doubt that GM i.p. injection generates a lot of oxidative stresses in the subjected experimental rats, and that could be noticed in Table (8) clearly in comparing the control groups; positive control group had been depleted significantly ($P<0.05$) in the content of superoxide dismutase (SOD) enzyme, whereas lipid peroxidation indicator (MDA) raised significantly ($P<0.05$), also NO level reflected high accumulation significantly in the kidney tissues concentration of C+ group than C- group.

Treated the experimental rats with GA with both shapes restored significantly ($P<0.05$) the kidney tissues' content of SOD enzyme, which mean scavenging process was done for ROS by GA supplementation. Furthermore, GA intervention in the two shapes eliminated significantly the recorded elevation of MDA and NO in the

kidney tissues' content comparing with C+ group. No significant difference was noticed between the two shapes used in the effectiveness on SOD or MDA levels of the intervention groups, only NO concentrations exhibited significant difference in the effectiveness of the two shapes used; powder form was more effective significantly.

Outcomes of GM injection agreed with **Tavafi*et al.*, (2012),** who elucidated that the mechanism of nephrotoxicity caused by GM could attributed to stimulation of reactive oxygen species (ROS) generation causing oxidative stress for tissues. Also, result of the present work was is in agreement with**Elgazar&AboRaya, (2013) and Shalaby&Hammouda, (2014),** who reported that daily intra-peritoneal injection with GM to rats for consecutive 8 days induced significant decrement in the activity of renal SOD comparing with the normal control group.

Table (8): Means ±SD **of superoxide dismutase (SOD), malondialdehyde (MDA) and nitric oxide (NO) for rats in controls and AG treated groups.**

Groups	**SOD** **U/gm**	**MDA** **mmol/gm**	**NO** **U/gm**
Control (C-)	**516.4**^{a}± 86	**52.6**^{e}± 6. 3	**75.52**^{e}± 12.2
Control (C+)	**387.6**^{e}± 61	**85.7**^{a}± 11. 5	**147.63**^{a}± 23.1
Gum Arabic (Solution feeding)	**474.3**^{b}± 52	**59.1**^{d}± 5.23	**104.14**^{c}± 17.6
Gum Arabic (Powder feeding)	**485.6**^{b}± 67	**60.5** ^{d}± 9. 5	**100.80**^{d}± 15.4

- Values which have different letters in the same column differed significantly at $p < 0.05$.

Regarding to themalondyaldehyd (MDA) level, the end product of lipid peroxidation, the present outcomes are in agreement with **Al-Kenanny*et al.*, (2012)**and**Alqasoumi, (2013),** who reported that injection withGM caused significant increment in the level of MDA. This result wasin agreement with some studies suggest that aminoglycoside antibiotics can stimulate the formation of reactive oxygen species (ROS), which may directly involve in renal failure and membrane lipid peroxidation **(Poormoosavi*et al*,. 2010)** and causing tissues oxidative stress **(Tavafi*et al.*,2012)**.

Nitric oxide (NO) is an important biological mediator **(Vane *et al.*, 1994)**,at physiological concentrations, NO inhibits proinflammatory platelet aggregation, integrin-mediated adhesion, and proinflammatory-induced gene expression, and these are factors that control vascular inflammation and oxidative injury**(Aktan,2004)**. Overall, the

overproduction of NO is important in inflammation and its related processes, but high levels of NO are markers for the diagnosis of inflammatory disorders.

GA has anti-oxidant property,**Ali, (2004)** testedtheGum Arabic effectiveness on the concentrations of some free radical scavengers; glutathione, ascorbic acid, lipid peroxidation and superoxide dismutase in the kidneys and liver of healthy rats, givenGum Arabic in the drinking water at concentrations 2.5, 5.0 or 10.0% for eight consecutive days. In agreement, results indicated that it has a palliative effect on renal failure through an antioxidant mechanism. Further study confirmed also thatGum Arabic has strong anti-oxidant properties, and a major mechanism for the induction of these toxicities is the generation of free radicals **(Ali *et al.*, 2008).**

Also, **Gado andAldahmash, (2013)** indicated that GA improved Hg-induced nephrotoxicity, manifested by a decrease in both serum creatinine and urea levels, and minimized the intensity of the renal lesions. The nephroprotective effect of GA against many nephrotoxic-agents was noted in several reports. The anti-oxidation induced by GA might be one of the most likely mechanisms contributing to its beneficial effect against renal injury. They mentioned that antioxidant effect ofGA was confirmed previously by *in-vitro* studies, and showed that GA had a dose-dependent scavenging for superoxide radicals generated enzymatically and nonenzymatically.

Present MDA results are in agree with that obtained by**Al-Kenanny*et al.*,(2012),**who found that treatment with GA showed significant reduction in serum MDA level, this result indicated that GA has ability as antioxidant reflected in hepatotoxicity amelioration, whichassured bythat MDA reduction. Whereas results were in consistent with**Al-Kenanny*et al.*, (2012),** whoreported that GA has free radical (nitric oxide) scavenging properties and macrophage inhibition functions **Fujiwara *et al.*, (1995).**Pretreatment of mice with Gum Arabic were found to produce significantly less nitric oxide (nitrate + nitrite) than acetaminophen-treated mice. The results were agreed with observations that Gum Arabic protects against gentamicin-induced nephrotoxicity**(Al-Majed*et al.*, 2002** and **Ali *et al.*, 2003)**. Also,**Rehman *et al.*, (2001**) reported that Gum Arabic has nitric oxide scavenging properties.

In a harmony with the present study, **Elshama*et al.*, (2014)**investigated the protective role of Gum Arabicinmodulation of

indomethacin systemic toxicity, the result indicated that; rats received 20 mg/kg/day of indomethacin with 10 gm/kg/day of Gum Arabicappeared a significant ($p<0.05$) decrease in the activity of renal MAD, NO and significant ($p<0.05$) increase in the level of SOD comparing with C+ group, which received indomethacin only.It could be deduce from the discussions regarding oxidant/antioxidant indicators that Gum Arabic played an important role as antioxidant agent, which ameliorated toxicity manifestations and scavenged most of ROS stressed as oxidations.

Kidneys' Histopathological Examination

The examinationofintact rats'kidneys revealed normal histological structure for renal parenchyma (glumeruli and tubules). Microscopically,cross section for kidney of rat from C- group exhibited normal histological structure for renal parenchyma(Photos 1&2). Meanwhile,cross section for kidney of rat from C+ group exhibited focal tubular necrosis associated with inflammatory cells infiltration(Photo 3) and peri-tubular inflammatory cells infiltration (photo4).Cross section for kidney of rat from C+ groupexhibited protein cast in the lumen of renal tubular (photo 5)andvacuolation of epithelial lining renal tubules and periglomerular inflammatory cells infiltration (photo 6) .It could be noticed thathistopathological changes resulted by GM in kidney of rats and the ameliorative effects by Gum Arabic in both shapeswere in harmony with the reported biochemical alterations.

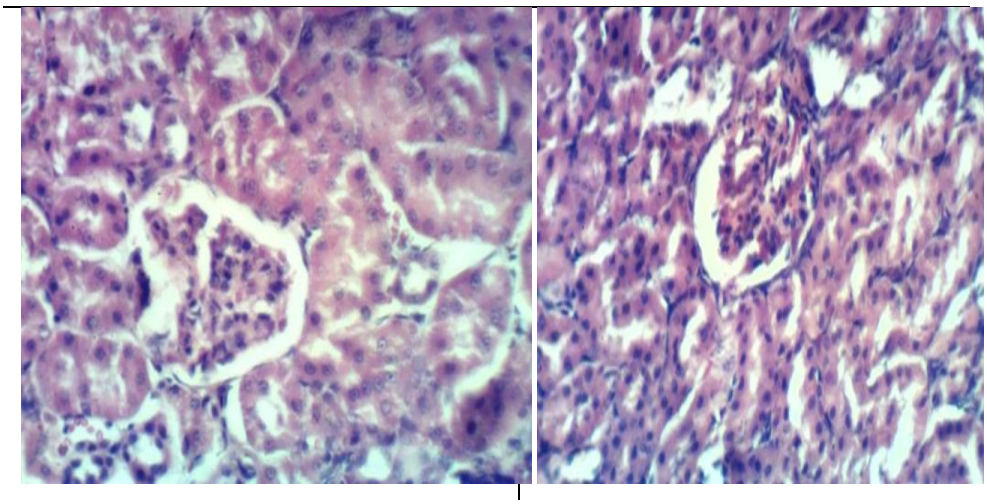
These resultsare in agreement with**McWilliam,(2007)** observations, which reported that injection withGM induced renal diseases and responsible for various pathological conditions of the kidney. Also, agreed with**Elgazar andAboRaya, (2013)**whoindicated that GM-injected rats exhibited marked necrosis forrenal tubules with protein cast in their lumens.Furthermore, agreed with **Shalaby and Hammouda, (2014)** who reported that kidney of healthy rats showed normal architecture of renal parenchyma (glumeruli and tubules) comparing withGM-intoxicated rat, which showed marked necrosis for renal tubules with protein casts in their lumens.

On the other hand, treating rats with GA insolutionshape group, exhibited protein cast in the lumen of renal tubular (photo 7)at the cross section of rat'skidney and no histopathological changes (photo 8). Meanwhile,Gum Arabicin powdershape group, exhibited focal tubular necrosis associated with inflammatory cells infiltration (photo 9)at the cross section of rat's kidney and no histopathological changes (photo

10).Theseobservationsare in agreement with **Gado and Aldahmash,(2013),** who reported that pathological examination for the kidneys of control and Gum Arabic groups showed normal morphology of the renal parenchyma, with well-defined glomeruli and tubules, with non-significant changes. They mentioned also that kidney specimens from rats treated with GA and Hg revealed significant improvement in glomeruli and renal tubules, evidenced by less vacuolization and more preservation of tubular histology.

On despite of all useful outcomes mentioned above for GA supplementations, no significant differences between the two shapes used were reported for the effectiveness on most parameters assessed; serum uric acid, urea,createnine, potassium&sodium electrolyte, AST & ALT activity, total protein, albumin, globulin, TC, TG, HDL-c, LDL-c, VLDL-c, SOD and MDA with exception for NO levels.

The study could be **concluding** that nutritional supplementation with Gum Arabic as colloidal solution (10%) or powder (2% of total diet) feeding ameliorated significantly the accompanied symptoms of acute Kidney injury (nephrotoxicity), without any significant difference for the effectiveness of the form used.



Photos (1 & 2): Cross section for Kidney of rat from C- group showing the normal histological structure at renal parenchyma
(H & E X 400).

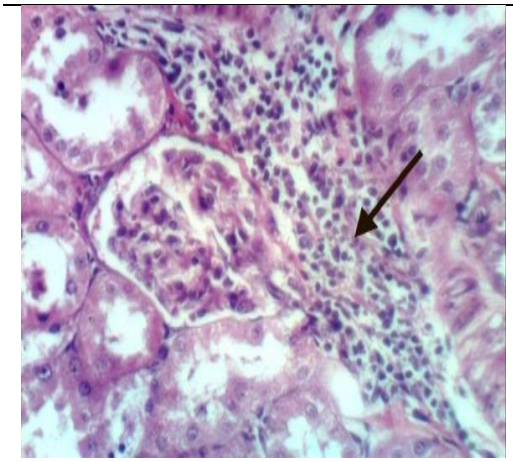


Photo (3): Cross section for Kidney of rat from C+ group showing focal tubular necrosis associated with inflammatory cells infiltration (H & E X 400).

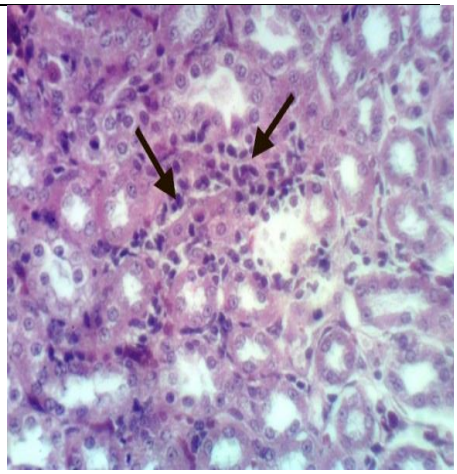


Photo (4): Cross section for Kidney of rat from C+ group showing peritubular inflammatory cells infiltration (H & E X 400).

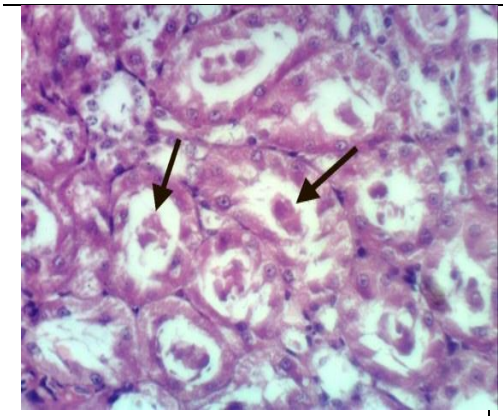


Photo (5): Cross section for Kidney of rat from C+ group showing protein cast in the lumen of renal tubular (H & E X 400).

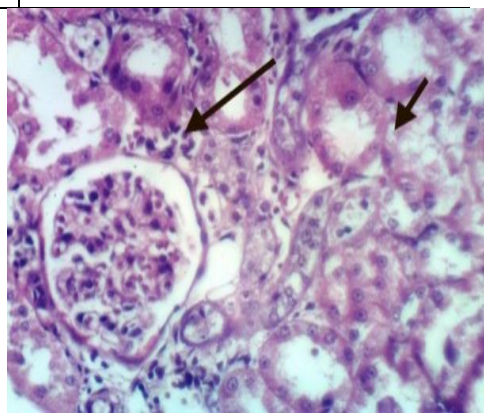


Photo (6): Cross section for Kidney of rat from C+ group showing vacuolation of epithelial lining renal tubules and periglomerular inflammatory cells infiltration (H & E X 400).

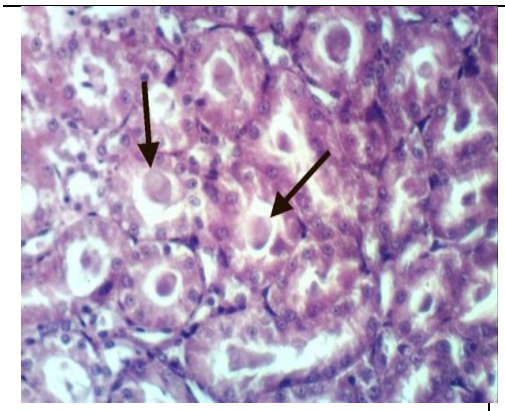


Photo (7): Cross section for Kidney of rat from Gum Arabic solution group showing protein cast in the lumen of renal tubular (H & E X 400)**.**

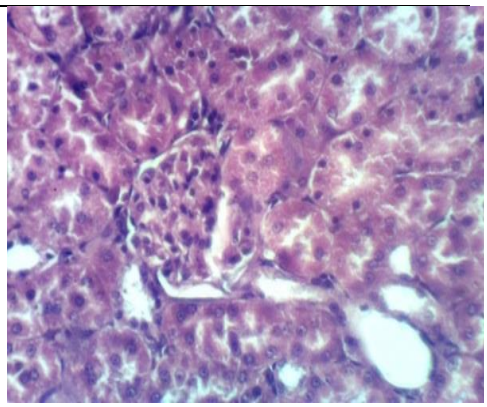


Photo (8): Cross section for Kidney of rat from Gum Arabicsolution group showing no histopathological changes (H & E X 400)**.**

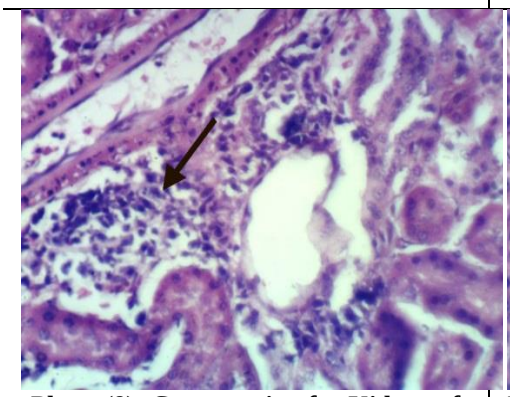


Photo (9): Cross section for Kidney of rat from Gum Arabicpowder group showing focal tubular necrosis associated with inflammatory cells infiltration (H & E X 400)**.**

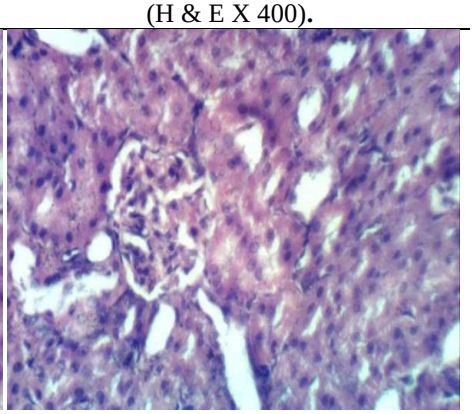


Photo (10): Cross section for Kidney of rat from Gum Arabicpowder group showing no histopathological changes (H & E X 400)**.**

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تأثير التغذية بالصمغ العربي "الحالة السائلة /الصلبة" على التلف الكلوي الحاد فى الجرذان

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قسم الإقتصادالمنزلى، تخصص تغذيه وعلوم أطعمة ، كلية التربية النوعية، جامعة عين شمس.

الملخص العربى

إختبرت العديد من الدراسات السابقة تأثيرات الصمغ العربي فى معالجة تراجع وظائف الكلى، ولكن هناكندرة فى المعلومات عن شكل التناول والذى يمكن ان يكون اكثر فاعليةللصمغالعربى. لذا أجريت الدراسهالحالية لفحص ومقارنة تأثير المأخوذمن الصمغ العربىفى الشكل السائل أو الطحين على فئران تجارب تعانى من التلف الكلوى الحاد (تسممكلوى)المفتعل بواسطة الجنتاميسين. تم تقسيم عدد إثنان وثلاثون جرذاً "سلالة سبراجيوداولى" تزن حوالى ١٥٠ جم بإنحرافمعيارى± ١٠ جم الى مجموعتين رئيسيتين: الأولى (ضابطه سالبه) ثمانى جرذان طبيعيين تغذوا على الغذاء القياسى، بينما المجموعه الرئيسية الثانية (عدد: ٢٤ جرذ) تم حقنهم فى الغشاء البريتونى بعقار الجنتاميسين بجرعه ٨٠ مليجم / كلجم من وزن الجسم / يوم لثمانية أيام متتالية لإحداث التلف الكلوى الحاد. وبعد التأكد من الإصابه، تم تقسيم الجرذان الى ثلاثة مجموعات فرعيه (ثمانية جرذان لكل مجموعه) وتم تغذيتهم على : غذاء قياسى فقط (ضابطه موجبه) أو مع تناول فموى لمحلول غروى ١٠% صمغ عربى (٢٠ ملليليتر/ كجم من وزن الجسم)، أو مع الدعم بنسبة ٢% من وزن الغذاء المتناول طحين صمغ عربى لمدة ٢٨ يوم متتالية. أظهرت النتائج ان الحقن بالجنتاميسين أزاد بدلالة احصائية (مستوى شك أقل من ٥%) مستويات حامض البوليك ، اليوريا، الكرياتينين، نشاط إنزيميAST&ALT، الكوليستيرولات الكلية، كوليستيرولاللبيوبروتينات منخفضة الكثافهبمصلالدموأيضاً مستويات المالونديالدهيدوأكسيد النيتريك بالنسيج الكلوى. بينما أظهرت نقص دال إحصائياً فى مستويات البوتاسيوم والصوديوم، البروتين الكلى، الالبيومين، الجلوبيولينبمصلالدم ومستويات انزيم السوبر اوكسيد ديسميوتيزبالنسيجالكلوىمقارنة بالمجموعه الضابطة السالبة. أدى التدخل الغذائى بالصمغ العربى الى شفاء (بدلالة إحصائية) كل هذه القياسات الحيوية، بينما لم يكن هناك إختلافات دالة إحصائياً لفاعلية الشكلين المتناولين المستخدمين فى كل القياسات التى تم تقييمها. وخلصت الدراسة الى ان الدعم الغذائى بالصمغ العربى كمحلول غروى (١٠%) أو طحين (٢%) قد أدى الى شفاء (بدلالة إحصائية) الأعراض المصاحبة لتلف الكلى الحاد (تسمم كلوى) مع إستعاده للتكوين الطبيعى لأنسجة الكلى، دون أىإختلافات ذات دلالة لشكل التناول المستخدم.

الكلمات الممفتاحية: الصمغ العربي، وظائف الكلى، انزيمات الكبد، صورة دهون الدم، إنزيم السوبر أوكسيد ديسميوتيز، مالونديالدهيد وأسيد النيتريك.