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Utilization of Pectin and Arabic Gum to Improve Kidney Functions in Rats Inflicted with Renal Failure

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Abstract :

Persons with chronic kidney disease (CKD) have significantly higher rates of morbidity, mortality, hospitalizations, and healthcare utilization. The prevalence of CKD stages had continued to increase since 1988 as have the prevalences of diabetes and hypertension, which are respectively etiologic in approximately 40% and 25% of CKD cases. Pectin as a biologically active supplement influence on some clinical and laboratory parameters which studied in 66 patients with chronic renal failure. The results of the investigations have evidenced that the studied biologically active supplements promotes a regress of clinical signs and elimination of uremic toxicants. Arabic gum (AG) is a complex polysaccharide used as suspending agent. It has been widely used by eastern folk medicine practitioners as a restorative agent and is thought to be an excellent curative for renal failure patients. This investigation aimed to study the effects of pectin and Arabic gum on kidney functions in rats inflicted with renal failure. Thirty five male albino rats weighing 150±5 g were divided into five equal groups; one group kept as control negative, while the other four groups were injected via intra-peritoneal by gentamicin at a dose of 100 ml/kg b. wt. for 7 days to induce Renal failure, one of them left as control positive while the rest three groups were fed on10% of the diet from (pectin, Arabic gum and a mixture of them) for 45 consecutive days. At the end of experimental period, blood samples were collected for serum separation to determine kidney functions (creatinine, urea and uric acid), total protein, total bilirubin, albumin, globulin, albumin/globulin (A/G) ratio, serum Na & K and liver enzymes(AST, ALT and ALP). Data showed that the dose of 10% of pectin, Arabic gum and a mixture of them

showed significant improvment in kidney function and enhancing in biological, biochemical and histopathological examinations in rats inflicted with renal failure.This study revealed that pectin, Arabic gum and a mixture of them at a dose of 10% of the diet could be used in the treatment of renal failure especially the mixture of them which not only slowed the progression of renal failure but also improved serum levels of total protein, albumin, globulin, albumin/globulin (A/G) ratio, serum Na & K and liver enzymes.

Key words: Renal failure, pectin , Arabic gum, rats, histopathological examinations.

Introduction:

Pectin are the ionic plant polysaccharides widely used in food industry because of their gelling and thickening properties **(Thakur *et al*., 1997).**It is a component of many feedstuffs, especially citrus and sugar beet pulp which are rich in pectin and to a limited degree it is present in grains and legumes. Pectin improves the stability and tight connection of plant cells, their osmolality and water content, and together with hemicellulose, cellulose and lignin reinforce the cell matrix **(Tatjana*et al*., 2009).** It is a group of complex polysaccharides that contain 1,4-linked-d-galacturonic acid **(Willats *et al.*, 2001).** There are three major pectic polysaccharides: Homogalacturonans, rhamnogalacturonans-I, and rhamnogalacturonans-II. Natural pectins are highly esterified and contain more than 50% of esterified carboxyl groups, whereas LE pectins can be prepared (**Ridley *et al.*, 2001).**

Arabic gum (AG) is a complex polysaccharide used as suspending agent. It has been widely used by eastern folk medicine practitioners as a restorative agent and is thought to be an excellent curative for renal failure patients. **(Al-Majed *et al*., 2003)**. It is defined by the FAO/WHO Joint Expert Committee for Food Additives (JECFA) as 'a dried exudation obtained from the stems of *A. senegal* (L.) Willdenow or closely related species of Acacia (family Leguminosae)' **(FAO, 1999).** It is a complex and variable mixtureture of arabinogalactan oligosaccharides, polysaccharides and glycoproteins. The molecular parameters and resulting functionality can vary greatly for different commercial samples **(Al-Assaf, *et al*., 2005).** Arabic gum is a non digestible polysaccharide that has been shown to retard glucose absorption. It has a low glycaemic index and reduces plasma glucose

concentrations in healthy individuals (**Phillips, 2009).** Moreover, it is used in the traditional treatment of patients with chronic renal disease and end stage renal disease in Middle Eastern Countries **(Bliss *et al*., 1996).**

Supplementation of the diet with Arabic gum has been shown to increase faecal nitrogen excretion and lower serum urea nitrogen concentration in patients with chronic renal failure **(Bliss *et al*., 1996).** This is dependent on increase in bacterial growth and activity in the gut. Colonic bacteria produce ureases that hydrolyse urea to ammonia and CO2. The resultant ammonia can then be incorporated into bacterial proteins, which are subsequently excreted in the bacterial mass fraction of the faeces. The net result is increased nitrogen excretion in the faeces. More recent studies, in rat models of acute renal failure **(Ali *et al*., 2003),** suggested that Arabic gum may also improve renal function independently of its action on faecal bacterial ammonia metabolism. Despite these reports the renal effects of Arabic gum in human renal disease remain ill-defined. More recently a single case report suggest a potential therapeutic role for Arabic gum in the treatment of renal disease in humans **(Al Mosawi, 2007).**

Therefore, this study aimed to study the effects of pectin and Arabic gum on kidney functions in rats inflicted with renal failure.

Materials And Methods :

a. *Materials :*

1. **Food items:** Pectin and Arabic gum (The dried exudates (gum) from *Acacia sudan* and related species (*Acacia seyal*)) were purchased from Algomhoria Co, Cairo (Egypt). These items were used at 10% level of the diet

2. Gentamicin: Obtained from the Farmacy.

3. Rats: Were purchased from Helwan experimental animal station.

b. Methods :

1. Biological Investigation:

Thirty five male albino rats Sprague Dawley strain weighing 150±5g were obtained from Helwan Experimental Animal Station and were delivered to the Laboratory of Animal Research, Faculty of Home Economics, Menoufia University. All rats were housed individually in well-aerated cages and fed on basal diet for one week for adaptation. The basal diet consisted of 70% corn starch, 10% casein, 10% corn oil,

4% salt mixture, 1% vitamin mixture, and 5% cellulose, as recommended by **(Campbell, 1963).**

2. Preparation of Renal Failure Rats:

Renal Failure was induced in normal healthy male albino rats via intra-peritoneal injection of gentamicin at a dose of 100 ml/kg b. wt. for 7 days according to the method described by **Farombi and Ekott (2006)**.

3. Experimental Design:

The rats were divided into two main groups, the first main group (7 rats) fed on basal diet as a control negative. The second main group (28 Renal failure rats) were divided into four groups (n=7) according to the following scheme:

1- Renal failure control group (control +ve).
2- Renal failure rats fed on basal diet+10% pectin for 45 consecutive days.
3- Renal failure rats fed on basal diet+10% Arabic gum for 45 consecutive days.
4- Renal failure rats fed on basal diet+10% mixture of pectin & Arabic gum for 45 consecutive days.

During the experimental period, the diet consumed was recorded every day, body weight was recorded every week. At the end of the experimental period, rats were fasted overnight before sacrificing. Blood sample were collected from aorta, in dry clean centrifuge tube, and left for 15 minutes to clot at room temperature, then centrifuged for 15 minutes at 3000 r.p.m to separate serum. Liver, spleen, heart, lung and kidneys were removed, cleaned and weighed.

4. Biological Evaluation:

All rats were weighted once weekly. At the end of the experiment, biological evaluation of the different diets was carried out by determination of body weight gain (BWG), feed intake (FI), feed efficiency ratio (FER) according to **Chapman *et al., (1959)*.** Using the following formulas .

$$\text{BWG} = \text{Final weight} - \text{Initial weight}$$

$$\text{FER} = \frac{\text{Gain in body weight (g)}}{\text{Feed Intake (g)}}$$

5. Analytical methods:

Serum creatinine, uric acid, and blood urea nitrogen (BUN) levels, as markers of renal function, were determined using the methods described by **Henry (1974)**, **Fossati *et al*., (1980)** and **Patton and Crouch (1977)**, respectively. Serum total protein, total billirubin and serum albumin levels were determined using the methods described by **Gornall *et al*., (1949)**, **Doumas *et al.,* (1973)** and **Doumas *et al.* (1971)**, respectively. Serum globulin was calculated as the difference between total protein and albumin. Serum sodium (Na) and potassium (K) levels were determined using the methods recommended by the **AOAC (2005).** Finally, serum liver enzymes(ALT, AST) were determined according to **Reitman and Frankel (1957**) and ALP was determined according to **Roy (1970).**

6. Histopathological examination

kidneys specimens were collected from rats of all experimental groups at the end of the experimental period, fixed in 10% neutral buffered formalin (pH=7.0), dehydrated in ethyl alcohol, then cleared in xylol and embedded in paraffin; 4-6 microns thickness sections prepared and stained with heamtoxylin and eosin for examining the kidney tissue using light microscope at various magnification **(Carleton, 1976).**

7. Statistical Analysis

Data were compared among the 5 groups by analysis of variance (ANOVA) using the procedure reported by (**Armitage and Berry, 1987).** The treatment means were compared using the least significant difference test (LSD) at a 5% level of probability, as reported by **(Waller and Duncan 1969).**

Results and Discussion:

1. Effect of pectin and Arabic gum on BWG, FI and FER for Renal failure rats:

The growth performance in terms of body weight gain, feed intake and feed efficiency ratio of control (-ve), control (+ve) and rats inflicted with renal failure then treated with pectin and Arabic gum diets are present in table (1).

Table (1): Effect of Pectin and Arabic gum on body weight gain (BWG), feed intake (FI), and feed efficiency ratio (FER) of renal failure rats

Parameters / Animal group	BWG (g)	FI (g)	FER
Control (-)	63.20±1.058 **a**	9.98±0.072 **d**	0.14±0.015 **a**
Control (+)	23.50±1.500 **e**	17.47±0.503 **a**	0.03±0.006 **e**
Pectin 10%	49.00±2.000 **c**	12.11±0.840 **c**	0.09±0.010 **c**
Arabic gum10%	36.00±1.323 **d**	13.61±0.535 **b**	0.06±0.015 **d**
Pectin & Arabic gum10%	57.30±1.473 **b**	10.54±0.505 **d**	0.12±0.012 **b**

Values denote arithmetic means ± standard deviation of the means.
Means with different letters (a, b, c, d) in the same column differ significantly at $p \leq 0.05$.
Using one way ANOVA test, while those with similar letters are non-significant.

It could be observed for rats inflicted with renal failure (control +ve) group that body weight gain was 23.50±1.500 compared to 63.20±1.058 g/45 day in control (-ve) group. These results denoted that there was significant decrease in BWG of control +ve group as compared to normal rats. All rats inflicted with renal failure and fed on pectin, Arabic gum and the mixture of them showed significant increase in BWG when compared to control positive group.

Inflicted rats with renal failure and fed on a mixture of pectin and Arabic gum showed the highest increase in BWG as compared to groups fed on pectin or Arabic gum groups which reached to 57.30±1.473 g/45 day as compared to 49.00±2.000 and 36.00±1.323 g/45 day, respectively.

Concerning feed efficiency ratio (FER), it is clear from the table that in control –ve group was 0.14±0.015 but in control +ve was 0.03± 0.006. This means that there were significant decrease in FER in rats inflicted with renal failure as compared to normal rats. There were significant increase in FER of rats fed on pectin, Arabic gum and a mixture of them as compared to control +ve group, which were 0.09±0.010, 0.06±0.015, 0.12±0.015 and 0.03±0.006 respectively. The highest significant value were in the mixtureture group.

These results confirmed by the findings of other authors. These results were in agreement with **(Wapnir *et al.*, 1997)** who showed that

drinking the Arabic gum supplemented oral rehydration salts (ORS) *ad libitum* showed accelerated recovery in comparison to those receiving either water or ORS without Arabic gum. Recovery parameters included greater enhancement of weight gain, feed and fluid intake, and a lower fecal output in rats whose ORS contained Arabic gum. This increase was evident after 4 h of recovery and persisted for 24 h. The authors ascribed the weight gain to the increased fluid intake and solid feed consumption. However, no ready explanation for the persistent increased solid feed intake was offered. The relative decrease of fecal output noted was ascribed to the increased fluid absorption – a feature that was also observed with Arabic gum in acute jejunal perfusion studies. The previous data suggested that Arabic gum is equally effective when consumed orally as when directly introduced post stomach, as in intestinal perfusion studies **(Rehman *et al.*, 2003 and Wingertzahn*et al.*, 2001)**. Moreover**, Samout *et al.*, (2016)** found that anti-obesity effects of the pectin molecule in several organs were mainly due to the interaction of its molecule with both the polysaccharide and the enzyme system which can be determined by phytochemical analysis.

Meanwhile,**Ali, *et al.*, (2004)** investigated the effect of treatment with Arabic gum in rats with experimental chronic renal failure (CRF). Some rats underwent two-stage surgical nephroectomy to induce CRF, and some were sham-operated. Arabic gum was then given to rats in the drinking water at doses of 3 or 6 g/100 mL/day for five consecutive weeks. Thereafter, rats were killed and the concentrations of urea and creatinine measured in their plasma. Body weights of all rats were taken every week during the experimental period. The significant increases in the concentrations of urea and creatinine, induced by experimental CRF were slightly and insignificantly ($P > 0.05$) decreased by Arabic gum by about 8 and 13% in rats treated at doses of 3 and 6 g/100 mL/day in the drinking water, respectively. Treatment with Arabic gum at the two doses did not significantly reverse the decrease in body weight in CRF rats.

2.Effect of Pectin and Arabic gum on organs weight in renal failure rats:

Data recorded in table (2) show the effect of pectin and Arabic gum on organs weight of rats inflicted with renal failure.

Table (2): Effect of pectin and Arabic gum on organs weight of renal failure rats

Parameters Animal group	Liver	Spleen	Heart	Lung	Kidneys
Control (-)	4.79±0.101 **d**	0.53±0.061 **c**	0.51±0.085 **c**	0.49±0.036 **d**	0.66±0.053 **d**
Control (+)	5.73±0.113 **a**	0.99±0.036 **a**	0.89±0.061 **a**	1.80±0.173 **a**	1.59±0.101 **a**
Pectin 10%	5.59±0.102 **b**	0.89±0.085 **a**	0.77±0.062 **b**	1.44±0.053 **b**	1.35±0.050 **b**
Arabic gum10%	5.17±0.112 **c**	0.74±0.053 **b**	0.75±0.087 **b**	1.09±0.085 **c**	1.04±0.053 **c**
Pectin & Arabic gum10%	5.49±0.165 **b**	0.93±0.052 **a**	0.79±0.036 **b**	1.50±0.171 **b**	1.39±0.102 **b**

Values denote arithmetic means ± standard deviation of the means.

Means with different letters (a, b, c, d) in the same column differ significantly at $p \leq 0.05$.

Using one way ANOVA test, while those with similar letters are non-significant.

It could be noticed that for control +ve group, the weight of liver, spleen, heart, lung and kidneys were 5.73±0.113, 0.99±0.036, 0.89±0.061, 1.80±1.173 and 1.59±0.101 g. b.wt., respectively. While in control -ve group the weight of the previously mentioned organs were 4.79±0.1010, 0.53±0.061, 0.51±0.085, 0.49±0.036 and 0.66±0.053 gb.wt., respectively. These data show that there were significant decrease in the weight of all mentioned organs of normal rats as compared to rats inflicted with renal failure.

All rats inflicted with renal failure and fed on pectin, Arabic gum and a mixtureture of them showed significant increase in all organs weight (liver, spleen, heart, lung, and kidneys as compared to control +ve group.

These data were in agreement with **(Tatjana*et al.*, 2009)** who demonstrated that pectin is an important factor affecting the proportions of faecal and urinary nitrogen excretion and ultimately both apparent protein digestibility and corrected apparent protein biological value. This effect related to the fermentability of pectin, especially in the large

intestine. Furthermore, their study confirmed the effects of pectin on digestive physiology, namely increased urea excretion from blood to intestine and reduced urea excretion by urine. Both consequences (in digestive tract and in kidney function) of the presence of pectin in the diet are of benefit for health status in animals and men. While**Faid (2013)** concluded that the mean values of internal organs weight as an effect of using Arabic gum is effective in decreasing the mean weight values of the heart, liver and kidney, however, the mean weight value of spleens is not effectively decreased.

3.Effect of pectin and Arabic gum on kidney functions (creatinine, urea and uric acid) in renal failure rats:

The effect of feeding with pectin and Arabic gum on renal function (creatinine, urea and uric acid) of rats inflicted with Renal failure is recorded in table (3)..

Table (3): Effect of pectin and Arabic gum on creatinine, urea and uric acid of renal failure rats

Parameters Animal group	Creatinine (mg/dL)	Urea (mg/dL)	Uric acid (mg/dL)
Control (-)	0.90±0.046 **c**	43.00±2.645 **d**	2.80±0.173 **d**
Control (+)	2.30±0.100 **a**	91.30±1.571 **a**	5.20±0.264 **a**
Pectin 10%	0.97±0.062 **c**	57.00±1.363 **c**	3.90±0.112 **c**
Arabic gum10%	1.90±0.181 **b**	66.00±1.732 **b**	4.40±0.361 **b**
Pectin & Arabic gum10%	0.93±0.026 **c**	45.00±4.583 **d**	3.00±0.235 **d**

Values denote arithmetic means ± standard deviation of the means.

Means with different letters (a, b, c, d) in the same column differ significantly at $p \leq 0.05$.

Using one way ANOVA test, while those with similar letters are non-significant.

It is clear from the table (3) that in rats inflicted with renal failure without treatment (control +ve group) the serum level of creatinine was 2.30 ± 0.100 compared to 0.90 ± 0.046 mg/dl in normal rats (control –ve group). These results showed that there were significant increase in serum creatinine in control +ve as compared to control –ve group. Rats fed on pectin, Arabic gum and a mixture of them revealed significant decrease in serum creatinine as compared to control +ve group which were 0.97±0.062, 1.90±0.181, 0.93±0.026 and 2.30±0.100 mg/dl respectively. There were non-significant changes between rats fed on

pectin, a mixture of pectin & Arabic gum and control –ve group which were 0.97±0.062, 0.93±0.026 and 0.90±0.046 mg/dl respectively.

Regarding serum urea of control +ve group, the level showed significant increase as compared to control –ve group which were 91.30 ± 1.571 and 43.00 ± 2.645 mg/dl respectively. All treated groups showed significant decrease in serum urea as compared to control +ve group which were 57.00 ± 1.363, 66.00 ± 1.732, 45.00 ± 4.583 and 91.30±1.571 mg/dl for pectin, Arabic gum, a mixture of them and control +ve group, respectively. The highest significant decrease was shown in rats fed on a mixture of pectin and Arabic gum as compared to control +ve but non-significant as compared to control –ve group.

Concerning serum uric acid of control +ve group, there were significant increase as compared to control –ve group which were 5.20 ± 0.264 and 2.80 ± 0.173 mg/dl respectively. All treated groups reflected significant decrease in serum uric acid as compared to control +ve group which were 3.90 ± 0.112, 4.40 ± 0.361, 3.00 ± 0.235 and 5.20 ± 0.264 mg/dl for pectin, Arabic gum, a mixture of them and control +ve groups respectively. The highest significant lowering showed in group fed on a mixture of pectin and Arabic gum as compared to control +ve but non-significant as compared to control –ve group.

These results confirmed with **(Khotimchenko, *et al*., 2009)** whoevaluated the efficacy of an enterosorbent based on low-esterified pectin, activated charcoal, and polyphepan in rats with experimental renal failure. Pectin was shown to be most effective. Its use causes increased daily diuresis and lower blood urine and creatinine levels in experimental animals. Their findings have led to the conclusion that low-esterified pectin may be used to design drugs for the complex treatment in patients with chronic renal failure. Meanwhile, **Bliss (1996)** concluded that serum urea nitrogen was significantly decreased during supplementation with Arabic gum compared with the baseline or supplementation with pectin. Nitrogen balance did not change significantly**.**

Similar results were obtained by **Al-Majed *et al*., (2003)** who concluded that Arabic gum (AG) protected the rats from gentamicin (GM)-induced nephrotoxicity, possibly, at least in part through inhibition of the production of oxygen free radicals that cause lipid peroxidation.

Moreover, **Ali *et al*., (2003)** assessed the effect of treatment of rats with Arabic gum on acute renal failure induced by gentamicin (GM) nephrotoxicity. Rats were treated with the vehicle (2 mL/kg of distilled water and 5% w/v cellulose, 10 days), Arabic gum (2 mL/kg of a 10% w/v aqueous suspension of Arabic gum powder, orally for 10 days), or Arabic gum concomitantly with GM (80mg/kg/day intramuscularly, during the last six days of the treatment period). Nephrotoxicity was assessed by measuring the concentrations of creatinine and urea in the plasma and reduced glutathione (GSH) in the kidney cortex, and by light microscopic examination of kidney sections. The results indicated that concomitant treatment with Arabic gum and GM significantly increased creatinine and urea by about 183 and 239%, respectively (compared to 432 and 346%, respectively, in rats treated with cellulose and GM), and decreased that of cortical GSH by 21% (compared to 27% in the cellulose plus GM group) The GM-induced proximal tubular necrosis appeared to be slightly less severe in rats given GM together with Arabic gum than in those given GM and cellulose. It could be inferred that Arabic gum treatment has induced a modest amelioration of some of the histological and biochemical indices of gentamicin (GM) nephrotoxicity. Further work is warranted on the effect of the treatments on renal functional aspects in models of chronic renal failure, and on the mechanism(s) involved.

4. Effect of pectin and Arabic gum on serum protein fractions (total protein, totl bilirubin, albumin, globulin and albumin/globulin ratio) for renal failure rats:

Effect of feeding with pectin and Arabic gum on total protein (T. protein), total bilirubin(T. Bilirubin), albumin, globulin and albumin/globulin(A/G) ratio for renal failure rats are recorded in table (4).

Table (4): Effect of pectin & Arabic gum on total protein (T. protein), total bilirubun(T. Bilirubin), albumin, globulin and albumin/globulin(A/G) ratio for renal failure rats

Parameters Animal group	T. protein (g/dL)	T.Bilirubin (g/dL)	Albumin (g/dL)	Globulin (g/dL)	A/G Ratio
Control (-)	9.40±0.265 **a**	0.50±0.044 **e**	6.50±0.249 **a**	2.90±0.171 **c**	2.24±1.456 **a**
Control (+)	7.20±0.164 **d**	1.70±0.173 **a**	3.10±0.173 **d**	4.10±0.346 **a**	0.76±0.500 **d**
Pectin 10%	8.80±0.173 **b**	0.90±0.164 **c**	5.90±0.361 **b**	2.90±0.265 **c**	2.03±1.362 **b**
Arabic gum10%	7.80±0.200 **c**	1.10±0.092 **b**	4.30±0.165 **c**	3.50±0.179 **b**	1.23±0.922 **c**
Pectin & Arabic Gum10%	8.90±0.216 **b**	0.70±0.089 **d**	6.00±0.436 **b**	2.90±0.361 **c**	2.07±1.208 **b**

Values denote arithmetic means ± standard deviation of the means.

Means with different letters (a, b, c, d) in the same column differ significantly at $p \leq 0.05$.

Using one way ANOVA test, while those with similar letters are non-significant.

It is clear from the table that total protein for renal failure rats without treatment (C +ve group) was 7.20 ± 0.164 compared to 9.40 ± 0.265 g/dL in (C -ve) normal rats. These results denote that there were significant decrease in T. protein of renal failure rats as compared to normal rats. All rats of renal failure and fed on all tested groups revealed significant increase in total protein when compared to control positive group. Pectin and the mixture of pectin and Arabic gum groups showed the highest significant increase in total protein as compared to control +ve group.

Meanwhile, total bilirubin for renal failure rats (C +ve group) was 1.70 ± 0.173 compared to 0.50 ± 0.044 g/dL in (C -ve) normal rats. These results denote that there were significant increase in total bilirubin of renal failure rats as compared to normal rats. All rats of renal failure and fed on all tested groups revealed significant decrease in total bilirubin when compared to control positive group. The mixture of pectin and Arabic gum group showed the highest significant decrease in total bilirubin as compared to control +ve group.

Moreover, albumin for control positive group was 3.10 ± 0.173 g/dL, showing significant decrease when compared to control –ve normal rats which was 6.50 ± 0.249 g/dL. All treatment groups showed significant increase in serum albumin when compared to control

positive group. Pectin and the mixture of pectin and Arabic gum groups showed the highest significant increase in albumin as compared to control +ve group.

Furthermore, globulin for control positive group was 4.10 ± 0.346 g/dL, showing significant increase when compared to control –ve normal rats which was 2.90 ± 0.171 g/dL. All groups showed significant decrease in serum albumin when compared to control positive group. It could be observed from the table that the mixture of pectin and Arabic gum group showed the highest significant decrease in globulin as compared to control +ve group, at the same time there was non significant change when compared to controle –ve group.

Concerning albumin/globulin(A/G) ratio there were significant decrease in control positive group when compared to normal rats ($P<0.05$) which were 0.76 ± 0.500 and 2.24 ± 1.456 respectively. All groups showed significant increase in albumin/globulin(A/G) ratio when compared to control positive group. It could be observed from the table that the mixture of pectin and Arabic gum group showed the highest significant increase as compared to control +ve group.

These findings were in agreement with **(Price *et al*., 2005)** who revealed that proteinuria is associated with cardiovascular and renal disease and is a predictor of end organ damage in patients with hypertension. Detection of an increase in protein excretion is known to have both diagnostic and prognostic value in the initial detection and confirmation of renal disease.

Morover, **Bliss *et al*., (1996)** demonstrated that in chronic renal failure (CRF), plasma concentrations of the products of protein metabolism are increased. Current dietary management is to prescribe a decrease in protein intake. The use of dietary fiber to increase fecal excretion of retained metabolites in CRF may be a beneficial adjunct to a low-protein diet (LPD). Colonic bacteria ferment dietary fiber, providing them with energy for growth and nitrogen incorporation, in turn, increasing nitrogen excretion in feces. Sixteen CRF patients consuming an LPD were randomly assigned to receive a supplement of a highly fermentable fiber, Arabic gum (50 g/d), or a placebo (1 g pectin/d) in a prospective, single-blind, crossover design. Fecal bacterial mass and fecal nitrogen content were significantly

increased during supplementation with Arabic gum compared with the baseline or supplementation with pectin.

As a supportive point, **Al-Mosawi (2004)** reported that to date there has been no published work on the use of Arabic gum in earlier stages of chronic kidney disease, but there are theoretical reasons behind benefits of its use. The areas in which had been concentrated are those looking at non renal clearance of urea that is seen with dietary fibres, its effects on glomerular filtration rate and effective renal plasma flow and its potential for affecting transforming growth factor beta (TGF-β) expression that could provide longer term benefits. The action of Arabic gum on TGF-β may also be of benefit in the shorter term as well as long term by its effects on blood pressure homeostasis.

5. Effect of pectin and Arabic gum on serum Na and K levels for renal failure rats:

Table (5) show the effect of feeding with pectin and Arabic gum on serum sodium (Na) and potassium (k) of rats inflicted with Renal failure.

Table (5): Effect of Pectin & Arabic Gum on Na and K of Renal failure rats

Parameters **Animal group**	**Na** **(mmol/L)**	**K** **(mmol/L)**
Control (-)	63.00±3.606 **e**	13.00±0.866 **a**
Control (+)	133.00±2.461 **a**	6.20±0.721 **d**
Pectin 10%	85.00±4.359 **c**	8.80±0.632 **b**
Arabic gum10%	95.00±3.305 **b**	6.90±0.854 **c**
Pectin & Arabic gum10%	74.00±2.571 **d**	8.40±0.529 **b**

Values denote arithmetic means ± standard deviation of the means.

Means with different letters (a, b, c, d) in the same column differ significantly at $p \leq 0.05$.

Using one way ANOVA test, while those with similar letters are non-significant.

The mean value of sodium for control –ve group was 63.00 ± 3.606 mm/L while in control +ve group was 133.00 ± 2.46/mm/L. These results denote that these were significant increase in serum sodium in control +ve group as compared to control –ve group. All rats inflicted with renal failure and fed on pectin, Arabic gum, and mixture of them

reflected significant decrease in serum sodium as compared to control +ve group while were 85.00 ± 4.359, 95.00 ± 3.305, 74.00 ± 2.571 and 133.00 ± 2.461 mmol/L, respectively.

Meanwhile, in serum potassium the mean value of control +ve group showed significant decrease as compared to control –ve group which were 6.20 ± 0.721 and 13.00 ± 0.866 mmol/L respectively. All treated groups which were fed on pectin, Arabic gum or a mixture of them caused significant increase in serum potassium as compared to control +ve group which were 8.80 ± 0.632, 6.90 ± 0.854, 8.40 ± 0.529 and 6.20 ± 0.721 mmol/L respectively. There were non-significant changes in mean value between rats treated with pectin or a mixture of pectin and Arabic gum which were 8.80 ± 0.632 and 8.40 ± 0.529 mmol/L respectively.

These data agreed withthat of **Shorecki and Ausiello (2011)** who demonstrated that Sodium Na+ is the major positive ion (cation) in body fluid outside of cells and potassium K+ is the major one inside the cells. Many processes in the body require electrical signals for communication. The movement of sodium and potassium is critical in generation of these electrical signals. Therefore variations in these cations level can cause cells to malfunction and can be fatal. Sodium and potassium regulate the total amount of water in the body and work to maintain the body's water balance also they play a role in critical body functions. One possible explanation for potassium's protective effect against hypertension is that increased potassium may increase the amount of sodium excreted from the body. Moreover, **Marwan (2014)** claimed that Arabic gum which sometimes used in medications, has been claimed to alleviate the adverse effects of chronic renal failure. The current study showed significant amelioration of the studied kidney parameters after daily treatment with a dose of 0.5 g/kg of Arabic gum, hence, it can be used as a potent therapeutic in the treatment of renal disorder (urea, creatinine and some electrolytes) resulted from cadmium toxication. The data supported the dietary fiber hypothesis which stated that there is a relationship between dietary fiber consumption and the improvement in renal malfunction.

More recently, **Nasir (2007)** studiedthe effect of Arabic gum on renal functions in healthy mice, claiming that it not only increased fecal weight consistent with the action of dietary fibers, but also showed

binding of free water, which resulted in reduction of intestinal fluid absorption and thus of urine volume. This was paralleled by an increase in antidiuretic hormone (ADH) secretion. **Wapnir*et al*., (1997)** claimed also that Arabic gum bound intestinal Na+, which was again reflected by reduced renal excretion. These findings were at variance with earlier findings that Arabic gum actually enhances water and Na+ absorption in a rat model of chronic-osmotic diarrhea by improving oral rehydration.

6. Effect of pectin and Arabic gum on liver enzymes (AST, ALT and ALP) for Renal failure rats:

Liver enzymes including aspartate amino trans aminase (AST), alanine amino trans ferase (ALT) and alkaline phosphatse(ALP) are listed as mean values in table (6).

Table (6): Effect of Pectin & Arabic Gum on AST, ALT and ALP of Renal failure rats

Parameters Animal group	AST (U/L)	ALT (U/L)	ALP (U/L)
Control (-)	40.00±1.000 **e**	9.98±0.072 **d**	190±8.660 **e**
Control (+)	78.00±3.464 **a**	17.47±0.503 **a**	310±18.028 **a**
Pectin 10%	45.00±3.166 **d**	12.11±0.840 **c**	230±17.321 **c**
Arabic gum10%	65.00±4.359 **b**	13.61±0.535 **b**	275±11.533 **b**
Pectin & Arabic gum10%	50.30±2.646 **c**	10.54±0.505 **d**	210±11.269 **d**

Values denote arithmetic means ± standard deviation of the means.

Means with different letters (a, b, c, d) in the same column differ significantly at $p \leq 0.05$.

Using one way ANOVA test, while those with similar letters are non-significant.

Data illustrated in table (6) show that they were significant increase in all previously mentioned liver enzymes for rats inflicted with renal failure as compared to normal rats which were 78.00 ± 3.464 and 40.00 ± 1.000 U/L for AST, 17.47 ± 0.503 and 9.98 ± 0.072 U/L for ALT and 310 ± 18.028 and 190 ± 8.660 U/L for ALP, respectively.

These data showed that feeding with pectin, Arabic gum and a mixture of them caused significant decrease in liver enzymes (AST, ALT and ALP) as compared to control +ve group. In ALT enzyme, rats inflicted with renal failure and fed on a mixture of pectin and Arabic gum showed the highest significant decrease as compared to control +ve group, at the same time, showing non-significant changes when

compared to control –ve group which were 10.54 ± 0.505 and 9.98 ± 0.072 U/L, respectively.

These findings agreed with **Khotimchenko *et al*.,(2009)** who studied the efficacy of an enterosorbent based on low-esterified pectin, activated charcoal, and polyphepan was evaluated in rats with experimental renal failure. Pectin was shown to be most effective. Its use causes increased daily diuresis and lower blood urine and creatinine levels in experimental animals. The findings had led to the conclusion that low-esterified pectin may be used to design drugs for the complex treatment in patients with chronic renal failure. Morover, **Bladergroen, *et al*., (1999)** evidenced that cholesterol and sphingomyelin metabolism were interrelated, and thus the hypothesis tested was that dietary pectin, because it can alter hepatic cholesterol metabolism, would also alter hepatic sphingomyelin metabolism. For that purpose, 4-wk-old female Wistar rats were fed a diet without or with pectin (20 g/100 g) up to 21 d. In accordance with previous work, pectin consumption caused a significant ($P < 0.001$) reduction in hepatic (65%), whole plasma (37%), and VLDL (80%) cholesterol levels. Pectin also significantly reduced VLDL sphingomyelin concentrations (57%), but raised the amount of sphingomyelin in the high density lipoproteins (HDL)-2 fractions (58%), so that the level of sphingomyelin in whole plasma remained unaffected. Pectin did not affect the sphingomyelin concentration in the liver. Pectin consumption did not affect the hepatic sphingomyelin synthesizing enzymes, serine palmitoyltransferase, phosphatidylcholine:ceramide phosphocholine transferase, or phosphatidylethanolamine:ceramide phosphoethanolamine transferase. In contrast, dietary pectin activated both lysosomal (28%) and plasma membrane (26%) sphingomyelinase and thus may have enhanced sphingomyelin degradation. An attempt was made to describe the effects of dietary pectin on sphingomyelin metabolism in terms of altered fluxes through liver and plasma, with whole liver and whole plasma concentrations of sphingomyelin remaining unaffected.

Moreover, **Samout *et al*., (2016)** evaluated the inhibitory effects of supplementation with apple pectin molecule on obesity. Under their experimental conditions, administration of pectin molecule decreased the total cholesterol (TC), LDL-cholesterol (LDL-ch) and triglycerides (TG) levels as well as AST, ALT, LDH, ALP, urea and uric acid (UC) levels

in blood serum; and increased the creatinine levels (Creat.), compared to high fat diet (HFD) group. Thiobarbeturic acid reactive substances (TBARS) concentrations decreased in liver, kidney, and serum by 20%, 29% and 19%, respectively, in a group treated with high-fat diet and pectin (HFD+Pec) compared to a HFD-treated group. The same treatment with pectin molecule increased superoxide dismutase, glutathion peroxidase and catalase activities by 39%, 14% and 16% in liver; 5%, 7% and 31% in kidney; and 9%, 32% and 22% in blood serum in the HFD Pectin-treated group.

7. Histological results:

Examination of kidneys for group 1 revealed the normal histological structure of renal parenchyma (Photo 1). On the other hand, kidneys from group 2 showed vacuolations of epithelial lining renal tubules and endothelial lining glomeruler tuft (Photo 2), focal tubular necrosis associated with leucocytic cells infiltration (Photo 3) as well as eosinophilic protein cast in the lumen of renal tubules (Photo 4). Kidneys from group 3 showed vacuolations of endothelial lining glomerular tuft, perivascluar edema and few leucoytic cells infiltration (Photo 5). Meanwhile, kidneys from group 4 revealed no changes except slight thickening in the partial layer of Bowman's capsule (Photo 6). Conversely, kidneys from group 5 revealed no histopathological changes (Photo 7).

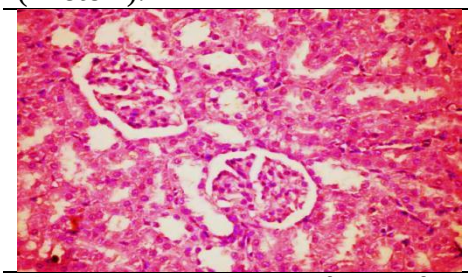	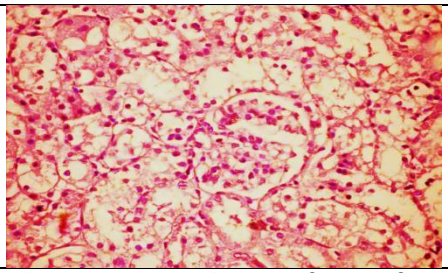
Photo (1): Kidney of rat from group 1 showing the normal histological structure of renal parenchyma (H and E X 200).	Photo (2): Kidney of rat from group 2 showing vacuolations of epithelial lining renal tubules and endothelial lining glomerular tuft (H and E X 200).

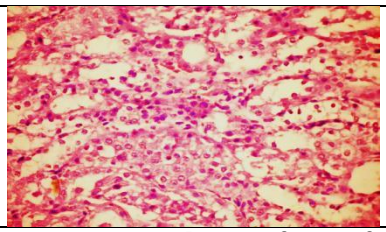

Photo (3) : Kidney of rat from group 2 showing focal tubular necrosis associated with leucocytic cells infiltration. (H and E X 200).

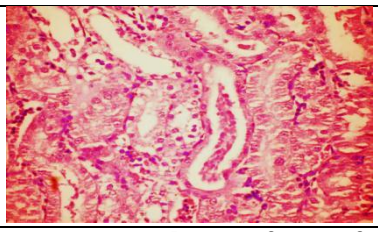

Photo (4): Kidney of rat from group 2 showing eosinophilic protein cast in the lumen of renal tubules (H and E X 200).

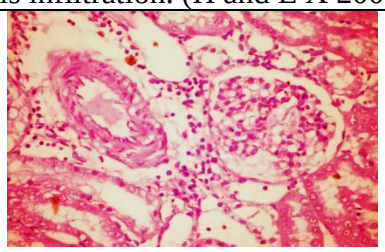

Photo (5): Kidney of rat from group 3 showing vacuolations of endothelial lining glomerular tuft, perivascular edema and few leucocytic cells infiltration (H and E X 200).

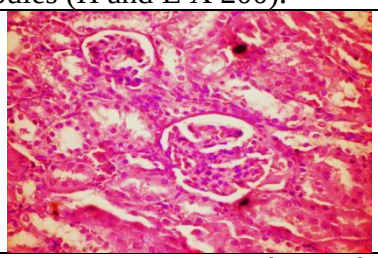

Photo (6): Kidney of rat from group 4 showing slight thickening in the parietal layer of Bowman's Capsule (H and E X 200).

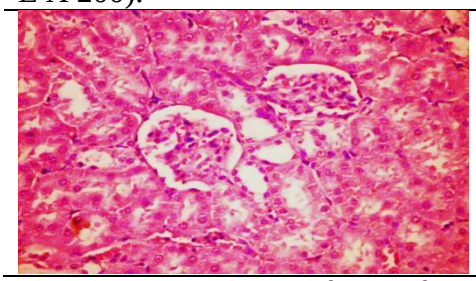

Photo (7): Kidney of rat from group 5 showing no histopatholical changes (H and E X 200).

In conclusion: This study revealed that pectin, Arabic gum amd a mixture of them at a dose of 10% of the diet could be used in the treatment of renal failure especially the mixture of them which not only slowed the progression elimination of renal failure but also improved serum levels of total protein, albumin, globulin, albumin/globulin (A/G) ratio, serum Na & K and liver enzymes.

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استخدام البكتين والصمغ العربي لتحسين وظائف الكلى في الفئران المصابة مع الفشل الكلوي

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الملخص العربي :

الاشخاص الذين يعانون من مرض الكلى المزمن لديهم معدلات مرتفعة من الامراض والوفيات واستخدام المستشفيات والرعاية الصحية. وقد زادت معدلات حدوث مراحل مرض الكلى المزمن منذ ١٩٨٨م حيث زادت معدلات حدوث البول السكري وارتفاع ضغط الدم والتي تمثل حوالى ٤٠% و ٢٥% على التوالي من حالات مرض الكلى المزمن. ويمتلك البكتين نشاط بيولوجي كمكمل غذائي لبعض القياسات السريرية والمختبرية والتي تمت دراستها على ٦٦ مريض فشل كلوي. وقد أثبتت نتائج الدراسات ان الاستخدام البيولوجي لتلك المكملات النشطة تحفز تقلص تلك المظاهر السريرية وتقضي على المواد السامة في البول. ويعتبر الصمغ العربي من السكريات المعقدة والذي يستخدم كمادة معلقة وأيضا يستخدم على نطاق واسع في الطب الشعبي الشرقي كعامل علاجي كما يعتقد أنه علاج ممتاز لمرضى الفشل الكلوي. استهدف العمل دراسة تأثير البكتين والصمغ العربي على وظائف الكلى في الفئران المصابة بالفشل الكلوي. تم استخدام ٣٥ فأر ألبينو أبيض ذات أوزان١٥٠±٥ جرام وتم تقسيم الفئران الى خمس مجموعات متساوية (كل مجموعة ٧ فئران) وتركت المجموعة الاولى لكى تمثل المجموعة الضابطة السالبة (الطبيعية) بينما الأربع مجموعات الباقية فتم حقنها بريتونيا بعقار الجنتاميسين عند جرعة ١٠٠مل/كجم لمدة ٧ أيام لا حداث الفشل الكلوي، ثم تركت مجموعة منهم كمجموعة ضابطة موجبة بينما الثلاث مجموعات الباقية فتم تغذيتهم على ١٠% من الوجبة من البكتين والصمغ العربي ومخلوطهما لمدة ٤٥ يوم متوالي. وفي نهاية التجربة تم تجميع عينات الدم وفصل السيرم لتقدير وظائف الكلى (كرياتينين-يوريا-حمض البوليك) والبروتين والبيليروبين الكلي والالبيومينوالجلوبيولين ومعدل الالبيومين إلى الجلوبيولين والصوديوم والبوتاسيوم في السيرم وانزيمات الكبد(اسبارتات امينو ترانسفيريز-الانين امينو ترانسفيريز- الكالين فوسفاتيز). وقد أظهرت النتائج أن جرعة الـ ١٠% من البكتين والصمغ العربي وخليطهما احدثت تحسنا معنويا في وظائف الكلى وتعزيز الاختبارات البيولوجية والكيميائية والهستوباثولوجية في الفئران المصابة بالفشل الكلوي. توصى الدراسة بأنه يمكن استخدام البكتين والصمغ العربي وخليطهما بجرعة ١٠٪ من الوجبة في علاج الفشل الكلوي وخاصة مخلوطهما والذي ليس فقط يقلل تعمق الفشل الكلوي ولكن يحسن أيضا مستويات البروتين والبيليروبين الكلي ومعدل الالبيومين إلى الجلوبيولين والصوديوم والبوتاسيوم وانزيمات الكبد في السيرم.

الكلمات المفتاحية: الفشل الكلوي– البكتين – الصمغ العربي – الفئران – الاختبارات الهستوباثولوجية.