Advances in Environmental Biology, 11(4) April 2017, Pages: 60-69

AENSI Journals

Advances in Environmental Biology

ISSN-1995-0756 EISSN-1998-1066

Journal home page: http://www.aensiweb.com/AEB/

Biological effects of low protein diet with gum Arabic on rats chronic kidney disease

Ebtihal Y. Khojah

Department of Nutrition and Food Science, College of Designs and Home Economics, Taif University, Saudi Arabia.

Address For Correspondence: Ebtihal Y. Khojah Department of Nutrition and Food Science, College of Designs and Home Economics, Taif University, Saudi Arabia.
E-mail: eykhojah@tu.edu.sa

Received 8 November 2016; Accepted 28 March 2017; Available online 15 April 2017

ABSTRACT
Gum Arabic is used in pharmaceutical, cosmetic and food industries as an emulsifier and stabilizer, and in some countries in the traditional treatment of patients with chronic kidney disease. Chronic kidney disease is characterized by progressive deterioration of kidney function, which develops eventually into a terminal stage of chronic kidney failure. The present study was carried out to explore the effect of gum Arabic with taken orally 1ml/day/kg body weight for each rat with low protein and the effect of some minerals on chronic kidney diseases in rats on nutritional status and serum minerals of rats suffering from chronic kidney disease. The mean values of serum sodium, potassium, uric acid, urea and creatinine were increased in chronic kidney disease group fed on basal diet containing 2% adenine (control positive) as compared to normal group fed on basal diet (control negative). Whereas, all groups were taken orally 1ml/day/kg body weigh rat from gum Arabic (GA) with all suggested diets leads to significant improvements in kidney and liver functions, nutritional status and serum minerals of rats suffering from chronic kidney disease chronic kidney disease. Gum Arabic was added to pomegranate juice at level 0.5, 1.5, 2.5 and 3.5% and the sensory characteristics such as flavor, aroma, color, texture and overall acceptability were evaluated. The results showed that the added gum Arabic to pomegranate juice till 2.5% was acceptability. From the obviously results it could be recommended that the gum Arabic was taken orally 1ml/Kg body weight for each rat/day with the all suggested diets leads to significant improvements in kidney functions, nutritional status and serum minerals of rats suffering from chronic kidney disease and the all diets from. Moreover, the addition of gum Arabic to pomegranate juice till 2.5 % was acceptability, safety and healthy.

KEY WORDS: Chronic kidney disease (CKD), Gum Arabic (GA), Pomegranate juice.

INTRODUCTION

Chronic kidney disease (CKD), a worldwide health problem, is a slowly progressive disorder that might lead to end-stage renal disease (ESRD). The prevalence of CKD has grown rapidly in both the developed and developing countries [1]. This trend is caused by a growing percentage of elderly people in the population as well as by technical progress and broader availability of dialysis therapy. An increasing number of diabetic patients are also an important factor [2]. CKD is characterized by progressive deterioration of kidney function, which develops eventually into a terminal stage of chronic kidney failure (CKF). CKF has traditionally been categorized as mild, moderate, or severe. Other poorly defined terms like uremia and end-stage renal disease (ESRD) have commonly been applied. During the last few years, an international consensus has emerged categorizing CKF into five stages according to the glomerular filtration rate (GFR) and presence of signs of kidney damage: stage 1: GFR > 90 ml/min and signs of kidney damage, stage 2: GFR = 60-89 ml/min and signs of kidney damage, stage 3: GFR = 30-59 ml/min, stage 4: GFR = 15-29 ml/min, and stage 5: GFR < 15 ml/min [3]. Stage 5 represents the total inability of kidneys to maintain homeostasis, and this metabolic state is incompatible with life. Thus, at this stage, it is necessary to use methods that substitute for kidney function to ensure patient survival; these methods include peritoneal dialysis, hemodialysis, and other extracorporeal purifying procedures, or kidney transplantation [4].

On the other side, the term ‘‘CKD-associated mineral and bone disorders’’ comprises abnormalities in bone and mineral metabolism and/or extra-skeletal calcification secondary to CKD pathophysiology [5]. The antihypertensive medications angiotensin-converting enzyme (ACE) inhibitors and angiotensin receptor blockers (ARB) are preferred agents for treatment of diabetic nephropathy [6]. Hyperkalemia is a common side effect. Individuals who develop mild to moderate hyperkalemia should receive nutritional counseling regarding a potassium restricted diet [7]. Maintaining normal serum phosphate levels is important for preventing renal bone disease and calcification of the soft tissue in people with CKD. Increase in blood phosphate is not usually seen until the later stages of CKD. Referral to a nephrologist is needed to optimize renal bone disease management through prescription of phosphorus binding medications and vitamin D derivatives. Counselling regarding a low phosphorus diet may often be delayed until the client is seen by a multidisciplinary renal team. Therefore, further studies are needed to explore the effect of low phosphorus and potassium diet (LPPD), on nutritional issues of rats suffering from chronic kidney disease [8].

Gum Arabic *(Acacia senega)* (GA), family *Fabaceae* is a small deciduous *Acacia* tree from the genus *Senegalia,* known by the common names Rfaudraksha, Gum Acacia, Gum Arabic Tree, or Gum Senegal Tree. It is native to semi-desert regions of Sub-Saharan Africa, as well as Oman, Pakistan, and northwestern India. It grows to a height of 5-12m, with a trunk up to 30 cm in diameter. *S. senegal* is the source of the world's highest quality gum Arabic, known locally as hashab gum in contrast to the related, but inferior, gum Arabic from *Red acacia* or talh gum. Like other legume species, *S. senegal* fixes nitrogen within *Rhizobia* or nitrogen-fixing bacteria living in root nodules. This nitrogen fixation enriches the poor soils where it is grown, allowing for the rotation of other crops in naturally nutrient-poor regions [9]. Moreover, Al-Mosawi [10] investigated that the possibility of using acacia gum supplementation to improve the quality of life and provide children with ESRD with a dialysis-free period. Both reported improved well-being. Neither became acidotic or uremic, and neither required dialysis during the study period. Both patients’ maintained urinary creatinine and urea levels not previously achieved without dialysis. In conclusion, dietary supplementation with acacia gum may be an alternative to renal replacement therapy to improve the quality of life and reduce or eliminate the need for dialysis in children with ESRD in some developing countries.

The modern pharmacological therapy is costly and associated with multiple side effects resulting in patient non-compliance. Thus there is a need to explore alternative therapies particularly from natural sources as these are cost effective and possess minimal side effects. In this attention, Gum Arabic (GA) or Acacia gum is an edible biopolymer obtained as exudates of mature trees of *Acacia senegal* and *Acacia seyal* which grow principally in the African region of Sahe in Sudan. The effective biological role of GA has confirmed in the last twenty years including reduction in plasma cholesterol level in animals and humans, anticarcinogenic effect [11] and antioxidant effect [12, 13] with a protective role against hepatic and cardiac toxicities. In addition to that, it has been claimed that GA alleviates effects of chronic renal failure in humans [14, 15]. It also has been shown to be effective in ameliorating the effects of adenine- induced CKD, one of the models employed to induce CKD in rats where adenine is given mixed with the feed at a concentration of 2% for four weeks [16, 17]. Both adenine and its metabolite, 2, 8-dihydroxyadenine (DHA), have low solubility and can precipitate in the renal tubules and form crystals. The consumption of oral adenine thus might cause the occlusion of renal tubules which retards the excretion of nitrogenous substances leading to a biochemical and physiological status resembling CKD in humans [18].

Pomegranate fruits peel is an inedible part obtained during processing of pomegranate juice. Pomegranate peel is a rich source of tannins, flavonoids and other phenolic compounds [19]. Antioxidant and antibacterial properties of pomegranate peel in in-vitro model systems have been reported [20, 21]. Pomegranate peel extract has both antioxidant and antimutagenic properties and may be exploited as biopreservative in food applications and neutraceuticals. However, so far, there has been no attempt to investigate the antioxidant properties of pomegranate in meat products [22].

The aim of this investigation was carried to evaluate the effect of gum Arabic was taken orally which supplemented with low protein diet and some minerals on chronic kidney diseases in rats. Kidney and liver functions were determined and also, antioxidant enzyme and serum minerals were measured. Gun Arabic was added to pomegranate juice at level 0.5, 1.5, 2.5 and 3.5% respectively and compared with pomegranate juice free addition during the sensory properties which evaluated.

MATERIALS AND METHODS

Materials:

Gum Arabic (Acacia senegal L.) GA and adenine were both obtained from Sigma (St. Louis, MO, USA). Adenine, analytical grade was used for induction of chronic kidney disease (CKD) among rats.

Kits for determination of renal and liver functions and other parameters were purchased from Alkan-Medical Division Biocon, Germany.

Fresh pomegranate fruit was obtained from local market at Saudi Arabia.

Methods:

Preparation of gum Arabic extract:

The plant was air dried; the coarse plant was powdered in a blender and subjected to successive aqueous extraction. The powder was soaked in 400 ml of hot distilled water with continuous stirring till became cool; the extract was filtered through cotton filter. Extract was stored in deep freeze [23].

Chemical and physical analysis of gum Arabic:

Chemical analysis as moisture, crude protein, crude fat, crude fiber and ash contents and also, the pH of 1% aqueous solution of gum Arabic (w/v) was measured using a glass electrode pH-meter (HANNA pH 210, UK) were determined using the methods described in the AOAC [24].

Physical properties as specific/optical rotation was determined for 1.0% (w/v) gum Arabic solution. The sample was dissolve and measurement was done using the Jusco P-1020 automatic polarimeter according to Anderson and Dea [25]. The Relative viscosity of the gum Arabic samples was measured at 25ºC by the use of viscometer according to AOAC [24] and the refractive index of 1% (w/v) aqueous solution of the gum Arabic sample was measured using the refractometer in the method described by Karamalla *et al.* [26].

Biological experimental:

Male albino rats (n=54 rats), 130-150g per each, were brought from House Experimental Animal, Center of King Fahd for Researches, University King Abdul-Aziz, Jada City, Saudi Arabia. The basal diet which consisted of corn starch 65%, casein 15% which contained on 12.6% protein, salt mixture 4%, vitamin mixture 1% and cellulose 5% was prepared according to AOAC [24]. Rats were housed individually in wire cages in a room maintained at 25 ± 2ºC and kept under normal healthy conditions. All rats were fed on basal diet for one-week before starting the experiment for acclimatization. After one week period, the rats were divided to two main groups; the first main group (6 rats) were fed on basal diet (BD) and described as control-ve. The second main group (48 rats) fed on basal diet plus 2 % adenine to induce chronic kidney disease (CKD) according to [16, 17]. After that the eight subgroups were fed on different diets for four weeks (experimental period) and the different formulae diets were used to feed different rats groups are reported in Table (A).

Main Group (1): Control negative (–ve) fed on basal diet.

The main group two was divided to eight subgroups (6 rats for each) as follows:

Group (2): Basal diet (BD) as control positive (control +ve) +2 % adenine.
Group (3): BD + 1 ml/day gum Arabic (GA) / Kg body weight for each rat+ 2 % adenine
Group (4): Low phosphorus and potassium diet (LPPD) + 2 % adenine
Group (5): LPPD + 1 ml/day gum Arabic (GA) / Kg body weight for each rat+2 % adenine
Group (6): Low protein diet (LPD) +2 % adenine.
Group (7): LPD + 1 ml/day gum Arabic (GA) / Kg body weight for each rat+2 % adenine.
Group (8): LPPD + LPD +2 % adenine.
Group (9): LPPD + LPD + 1 ml/day gum Arabic (GA) / Kg body weight for each rat +2 % adenine.

Table A: Formulae of the diets used to feed different rats groups:

Groups / Diets	Group 1 (–ve)	Group 2 (+ve)	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9
Casein	15.0	15.0	15.0	15.0	15.0	10.0	10.0	10.0	10.0
Corn oil	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Cellulose	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Salt mix	2.12	2.12	2.12	3.4	3.4	2.12	2.12	3.4	3.4
Vitamin mix	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Starch	63.0	63.0	63.0	63.0	63.0	68.0	68.0	68.0	68.0
Phosphorus	1.18	1.18	1.18	0.3	0.3	1.18	1.18	0.3	0.3
Potassium	0.7	0.7	0.7	0.3	0.3	0.7	0.7	0.3	0.3
Adenine	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Gum Arabic	--	--	1ml/ day	--	1ml/ day	--	1ml/ day	--	1ml/ day

At the end of experiment period, four weeks, blood samples were collected after 12 hours fasting using the abdominal aorta and rats were scarified under ether anesthetized. Blood samples were withdrawn from the antecubital vein into glass centrifuge tubes, containing oxalate solution (1.34 %) as anticoagulant. After centrifugation at 3000 rpm for 10 min., plasma was with drown and used for the analysis. Liver functions as serum aspartate aminotransferase (AST), alanine aminotransferase (ALT) activities were measured in serum using the modified kinetic method with Tietz *et al.* [27] and alkaline phosphates activity (ALP) was determined using modified kinetic method of [28]. Kidney functions as serum uric acid, creatinine and urea were estimated according to the method described by [29, 30, 31], respectively.

Sodium (Na) and potassium (K) content in plasma samples were determined by the adaptation the method mentioned by Doku and Gadzekpo [32].

Antioxidant activity of glutathione peroxidase (GSH-Px) and catalase CAT were measured using the [33, 34**]** spectrophotometry method with cumene hydroperoxide, and total superoxide dismutase (SOD) was determined spectrophotometrically according to the method of Aebi [35].

Preparation of pomegranate juice:

Pomegranate fruits were washed by distilled water then peeled and their edible pulp (arils) were carefully separated. Pomegranate juice (control) was prepared as follows: The edible pulp (arils) from the pomegranate fruit containing the intact extract sacs were manual1y separated from the pericarps and the sacks, and ruptured by very light agitation in an electric blender for 5-10 sec. The resulting extract was then centrifuged at 3000 rpm for 10 min. The supernatants from the centrifugation step of the pomegranate juice were recovered, filtered and aliquot according to [36]. Finely the treatment juice was prepared separately by adding 0.5, 1.5, 2.5 and 3.5 gram Arabic gum to 100 ml. pomegranate juice and immediately stored at -20^{o} C prior to experimentation to sensory evaluation. Pomegranate juice considerable as control was prepared without addition.

Table G: Recipe of pomegranate juice:

Juice number	Recipe
Pomegranate juice free	Pomegranate juice without addition as control
Pomegranate juice A	0.5 gram gum Arabic /100ml pomegranate juice
Pomegranate juice B	1.5 gram gum Arabic /100ml pomegranate juice
Pomegranate juice C	2.5 gram gum Arabic /100ml pomegranate juice
Pomegranate juice D	3.5 gram gum Arabic /100ml pomegranate juice

Sensory characteristics of pomegranate juice:

The organoleptic characteristics of pomegranate juice were conducted to determine the acceptability of the product. Pomegranate juice were presented in a bottle coded with different numbers to ten from the staff members of the Department of Nutrition and Food Science, College of Designs and Home Economics, Taif University, Saudi Arabia panelists were asked to rate each sensory attribute. Pomegranate juice samples were evaluated for color, taste, texture, flavor and overall quality according to Tehranifar *et al*. [37].

Statistical Analysis:

The obtained data were exposed to analysis of variance. Duncan's multiple range tests at ($P \leq 0.05$) level was used to compare between means. The analysis was carried out using the PRO ANOVA procedure of Statistical Analysis System [38].

RESULTS AND DISCUSSION

Chemical and physical properties of gum Arabic:

Table (1) showed that the chemical compositions as moisture, total protein, crude fat, crude fiber, ash and total carbohydrates content of GA sample were 12.21, 3.22, 0.18, 93.26, 2.47 and 0.87%, respectively. Dauqan and Abdullah [39] who found the chemical composition of GA as moisture content, ash content, Internal energy, volatile matter, optical rotation (degrees), total protein and nitrogen content were 13-15%, 2-4%,30-39%, 51-56%, -26 to -34 degree, 0.71- 4.18 and 0.26-0.39%. The chemical composition of GA can vary with its source, the age of the trees from which it was obtained, climatic conditions and soil environment. Gum Arabic is a branched-chain, complex polysaccharide, either neutral or slightly acidic, found as mixed calcium, magnesium and potassium salt of a polysaccharidic acid [40]. Gum Arabic is rich in dietary fiber that is derived from dried exudates of A. senegal [41], It contains a high molecular weight (lipoprotein) heterogeneous gum polysaccharides [42].

Carbohydrates were determined by difference:

Data in the Table (2) indicated that the physical properties of gum Arabic (*Acacia senegal*) sample. Results indicated that gum Arabic (*Acacia senega*l) had specific rotation (-28.11) and relative viscosity (14.98). It was also observed that the pH of the gum samples changes with change in concentration of the aqueous solution. This is similar to observation made by [43] in which a mean pH of 4.5–5.5 was reported with difference in concentration. A value of 1.351 was obtained for refractive index which is similar to value of 1.35 reported for Arabic gum. The Refractive index (1.38) and pH (4.69) which is agree with those obtained by [44, 45].

Table 1: Chemical (g/100g) characteristics of gum Arabic.

Chemical characteristics	Gum Arabic (G A) %
Moisture content	12.21
Total protein	3.22
Crude fat	0.18
Crude fiber	93.26
Ash content	2.47
*Total Carbohydrates	0.87

Table 2: Physical charactarestics of gum Arabic.

Physical characteristics	Gum Arabic (G A) %
Specific rotation (degree)	-28.11
Relative viscosity	14.98
Refractive index (cps)	1.38
pH	4.69
Solubility (Percentage, w/v)	25.66

Effect of different diets on kidney functions of rats suffering from chronic kidney disease:

Data presented in Table (3**)** showed that the effect of gum Arabic supplemented with low protein and some minerals on chronic kidney diseases in rats. Serum uric acid, urea and creatinine were determined in rats suffering from chronic kidney disease. From the resultant it could be noticed that the mean values of uric acid and creatinine levels increased in chronic renal failure (CRF) group fed on basal diet containing 2% adenine (control positive) as compared to normal group fed on basal diet (Control negative). The mean values of uric acid, urea and creatinine levels of the negative control group fed on basal diet were 1.26, 42.65 and 0.71 mg/dl, while their levels of (CRF) group fed on BD containing 2% adenine (Control positive) were 3.31, 46.62 and 3.48 mg/dl. Whereas the groups fed separately on phosphorus and potassium diet (LPPD) and low protein diet (LPD) containing 2% adenine and 1 ml/day gum Arabic (GA) / Kg body weight for each rat was taken orally (group 5 and 7) led to decrease in uric acid, urea and creatinine levels by the rates of 2.59, 40.65 and 2.61 mg/dl in group 5 and in group 8 it was 2.45, 38.21 and 2.53 mg/dl, respectively. Moreover, the group fed on LPD plus LPPD containing 2% adenine and 1 ml/day gum Arabic (GA) / Kg body weight for each rat was taken orally (group 9) exhibited synergistic effect and recorded the highest decreasing rate in uric acids, urea and creatinine levels were 2.16, 36.75 and 2.50 mg/dl, respectively. Whilst, the rat groups fed on different diet containing 2% adenine and without taken orally rats gum Arabic significantly increased in the uric acid, urea and creatinine levels. Finally, the addition of gum Arabic (GA) to the all suggested diets leads to significant decreasing in the uric acid, urea and creatinine levels.

The kidneys perform the essential function of removing waste products from the blood and regulating the water fluid levels. The kidneys receive blood through the renal artery. The blood is passed through the structure of the kidneys called nephrons, where waste products and excess water pass out of the blood stream. Kidney disease occurs when the nephrons inside the kidneys, which act as blood filters, are damaged. This leads to the buildup of waste and fluids inside the body [46]. Drug overdoses, accidental or from chemical overloads of drugs such as antibiotics or chemotherapy, may also cause the onset of acute kidney failure. Overuse of common drugs such as aspirin, ibuprofen, and acetaminophen (paracetamol) can also cause chronic kidney damage [47].

Urea is formed in the liver as the end product of protein metabolism. During ingestion, protein is broke down into amino acids. In the liver, these amino acids are catbolized and free ammonia is formed. The ammonia is combined to form urea. Urea, the major product of protein catabolism measuring urea is the most popular laboratory procedure for assessing renal function [48]. Creatinine is a catabolic product of creatine phosphate, which is used in skeletal muscle concentration [49]. In the skeletal muscle serum creatinine levels are elevated by renal disease and dehydration. Moreover, the GA was taken with the diet has been shown to increase fecal nitrogen excretion and decrease serum urea nitrogen concentration in patients with CKD, and this was shown to be dependent on increased bacterial growth and activity in the gut [50]. Colonic bacteria produce ureases that hydrolyze urea to ammonia and carbon dioxide. The resultant ammonia can then be incorporated into bacterial proteins, which are subsequently excreted in the bacterial mass fraction of the feces. The net result is increased N excretion in the feces [15].

Table 3: Effect of different diets on serum uric acid and creatinine of rats suffering chronic kidney disease (mg dl).

Groups	Serum uric acid	Serum urea	Serum creatinine
Group 1	1.62±0.12	42.65 ± 1.28	0.71±0.17
Group 2	3.31±0.23	46.62 ± 1.81	3.48±0.32
Group 3	3.07±0.41	42.48 ± 0.35	3.10±0.55
Group 4	2.80±0.17	41.60 ± 2.46	2.74±0.34
Group 5	2.59±0.12	40.65 ± 1.17b	2.61±0.22
Group 6	2.95±0.24	43.29±1.48	2.90±0.15
Group 7	2.45±0.31	38.21±1.02	2.53±0.12
Group 8	2.65±0.19	39.65±1..54	2.75±0.17

Group 9	2.16±0.25	36.75 ± 1.22	2.50±0.32

Effect of different diets on liver functions of rats suffering chronic kidney disease:

Table (4) showed that resultant from the serum aspartate aminotransferase (AST), alanine aminotransferase (ALT) activities and alkaline phosphates activity (ALP) in the different rat groups suffering chronic kidney disease fed on different diets. The mean value of AST, ALT and ALP activities of the negative control group fed on basal diet was 79.11, 30.60 and 101.21 IU, while AST, ALT and ALP activities of chronic renal failure (CRF) group fed on BD containing 2% adenine (Control positive) was 110.12, 65.95 and 191.24 IU. These results from positive control showed that increasing about negative control in AST, ALT and ALP activities was 39.21, 115.54 and 88.95%. Whereas, the groups fed separately on phosphorus and potassium diet (LPPD) and low protein diet (LPD) containing 2% adenine and 1 ml/day gum Arabic (GA) / Kg body weight for each rat was taken orally (group 5 and 7) led to decrease in AST, ALT and ALP activities by the rates of 21.77**,** 17.49 and 30.55 and 18.01, 16.36 and 27.76%, respectively compared with control positive. Moreover, the group fed on LPD plus LPPD containing 2% adenine and 1 ml/day gum Arabic (GA) / Kg body weight for each rat was taken orally (group 9) exhibited synergistic effect and it was recorded the highest decreasing in the resultant from AST, ALT and ALP activities 22.21, 31.40 and 47.08%, respectively compared with control positive. Finally, the addition of gum Arabic (GA) to the all suggested diets leads to significant decreasing in the AST, ALT and ALP activities. Data of the present study are in accordance with that observed by Abd-ELFattah *et al.* [51] who found that rats fed on diet containing 2% adenine showed a significantly higher value of AST and ALT. This may be referred into a direct excessive effect of adenine on AST and ALT enzymes. This significant increasing in AST and ALT may be attributed mainly to the hepatotoxic effect of adenine. Also, Kuntz [**52]** reported that feeding of rats suffering from chronic kidney disease with LPD induced significant improving in the liver functions i.e. AST and ALT activities.

Table 4: Effect of different diets on aspartate aminotransferase (AST), alanine aminotransferase (ALT) and alkaline phosphatase (ALP) (IU) of rats suffering from chronic kidney disease.

Groups	AST	ALT	ALP
Group 1	79.11±2.67	30.60±3.76	101.21±7.85
Group 2	110.12±11.76	65.95±7.98	191.24±6.55
Group 3	99.80±3.01	61.44±2.88	165.19±11.09
Group 4	91.69±4.25	56.67±3.83	138.20±9.45
Group 5	86.14±3.88	54.41±2.89	132.81±5.87
Group 6	100.28±4.98	59.38±5.21	141.00±14.34
Group 7	90.29±5.52	55.16±4.72	138.15±10.76
Group 8	87.13±2.99	53.60±6.09	125.51±10.11
Group 9	85.66±3.18	45.24±4.09	101.21±7.85

Effect of different diets on serum sodium and potassium levels of rats suffering from chronic kidney disease:

Data presented in Table (5) showed that the effects of low phosphorus and potassium diet (LPPD), low protein diet (LPD) and gum Arabic (GA) on sodium and potassium levels of rats suffering from chronic kidney disease. From the resultant it could be noticed that the mean value of sodium and potassium levels increased in chronic renal failure (CRF) group fed on diet containing 2% adenine (control positive) as compared to normal group fed on basal diet (control negative). The mean value of sodium and potassium levels of the negative control group fed on basal diet was 117.91 and 3.16 mmol/l, while their levels of chronic renal failure group fed on basal diet containing 2% adenine (control +ve) was 161.09 and 5.05 mmol/l, respectively. The rate increasing for control positive in sodium and potassium levels than control negative as the result of chronic renal failure (CRF) induction was 36.62 and 59.79%, respectively. Whereas the groups fed separately on phosphorus and potassium diet (LPPD) and low protein diet (LPD) containing 2% adenine and 1 ml/day gum Arabic (GA) / Kg body weight for each rat was taken orally (group 5 and 7) led to decrease in sodium and potassium levels to 146.94 amd 4.09 mmol/l in group 5 and in group 7 was 133.74 and 3.81 mmol/l, respectively. Moreover, the group fed on LPD plus LPPD containing 2% adenine and 1 ml/day gum Arabic (GA) / Kg body weight for each rat was taken orally (group 9) exhibited synergistic effect and recorded the highest decreasing rates in sodium and potassium levels, 19.93 and 35.04 % than control positive. Finally, the addition of gum Arabic (GA) to the all suggested diets leads to significant decreasing in the sodium and potassium levels. These changes lead to ineffective energy generation despite adequate intake of protein and carbohydrate substrates. In more extreme manifestations, these alterations in nutrient use cause ‘‘uremic malnutrition,’’ a syndrome that is distinct from malnutrition caused by inadequate nutrient intake.

Both inadequate nutrient intake and ineffective nutrient use can contribute to nutritional disorders in CKD patients [53]. In similar study, Ammar [54] reported that the best results of serum sodium and potassium recorded for the group fed on low protein (LPD), phosphorus and potassium diet (PPD) and treated daily with 15% gum Arabic. These treatments decreased serum sodium and potassium by about 9.72 and 26.11% for LPD and 9.26 and 20.94% for PPD, respectively, as compared to the positive control group.

Table 5: Effect of low different diets on serum sodium and potassium levels mmol/l^{-1} of rats suffering from chronic kidney disease.

Groups	Sodium	Potassium
Group 1	117.91±4.85	3.16±0.32
Group 2	161.09±5.23	5.05±0.75
Group 3	155.68±6.05	4.50±1.05
Group 4	152.85±4.76	4.08±0.32
Group 5	146.94±13.12	3.89±0.61
Group 6	141.16±14.56	4.09±0.27
Group 7	133.74±6.54	3.81±0.44
Group 8	136.47±8.88	3.93±0.88
Group 9	128.98±9.99	3.28±0.51

Effect of different diets on antioxidant enzymes activities of rats suffering from chronic kidney disease:

From the resultant in Table (6) it could be noticed that the mean value of glutathione peroxidase (GSH-Px), catalase CAT and total superoxide dismutase (SOD) activities of the control negative fed on basal diet were 17.95, 3.82 and 179.12 U.g^{-1} Hb while GSH-Px, SOD and CAT activities of CRF group fed on BD containing 2% adenine (control positive) were 12.04, 2.53 and 132.51 U.g^{-1} Hb, respectively. The rate of increasing in control negative for GSH-Px, SOD and CAT activities were 32.92, 33.77 and 26.02%, respectively than control positive. Whereas the groups fed separately on phosphorus and potassium diet (LPPD) and low protein diet (LPD) containing 2% adenine and 1 ml/day gum Arabic (GA) / Kg body weight for each rat was taken orally (group 5 and 7) led to increase in GSH-Px, SOD and CAT activities by the rates of 25.74, 21.73 and 12.59% in group 5 and in group 7 was 24.75, 18.97 and 16.45%, respectively, than control positive. Moreover, the group fed on LPD plus LPPD containing 2% adenine and 1 ml/day gum Arabic (GA) / Kg body weight for each rat was taken orally (group 9) exhibited synergistic effect and recorded the highest decreasing rate in GSH-Px, SOD and CAT activities (29.65, 24.90 and 25.42%). Finally, the addition of gum Arabic (GA) to the all suggested diets leads to significant decreasing in the GSH-Px, SOD and CAT activities. Superoxide dismutase (SOD), catalase (CAT) and the enzyme of the glutathione redox cycle i.e. glutathione peroxidase (GSH-Px) and glutathione reductase (GSH-Rd) are the primary intracellular antioxidants and are considered to be preventive or primary, antioxidant as they prevent free radical chain reaction by decreasing the available concentration of free radical to initiate the process [55].

Sensory evaluation of pomegranate juice:

To the consumer, the most important attributes of a food are its sensory characteristics such as flavor, aroma, color, texture and overall acceptability were determined in different juice and the results are reported in Table (7). Thus, sensory evaluation was performed for this product in order to determine the most acceptable sample by the panelists. The panelists prepared were palatability tested in terms of taste, after-taste, color, aroma and overall acceptability by panelists. With regard to the same pomegranate juice, there were no significant differences among for pomegranate juice number A, B and C made from 0.5, 1.5 and 2.5% gum Arabic in their taste, color, flavor and texture. Whereas the pomegranate juice number D was rejected in overall acceptability by panelists.

Table 6: Effect of different diets on glutathione peroxidase (GSH-Px), Superoxide dismutase (SOD) and catalase (CAT) (U g^{-1} Hb) of rats suffering from chronic kidney disease.

Groups	GSH-Px	SOD	CAT
Group 1	17.95±1.09	3.82±0.09	179.12±10.78
Group 2	12.04±2.23	2.53±0.67	132.51±4.84
Group 3	13.01±1.11	2.70±0.34	140.19±5.11
Group 4	14.79±0.89	2.94±0.27	149.57±5.06
Group 5	15.02±1.05	3.01±0.56	154.32±9.87
Group 6	13.84±0.85	2.85±0.27	145.11±7.21
Group 7	15.14±2.09	3.08±0.39	158.71±8.45
Group 8	14.15±2.16	3.90±0.34	149.20±10.78
Group 9	15.61±1.34	3.16±0.94	166.20±11.06

Sensory quality attributes and nutritive value of fruit play an important role in consumer satisfaction and they influence further consumption. Sensory ratings of fruit by panelists and physical measurements of fruit properties are useful methods in the evaluation of fruit quality [56]. Sensory quality is a difficult concept to define; it should be comprehended as interaction between the product and the consumer. It is necessary to establish a relationship between the physical and chemical composition of the product and its sensory attributes such as color, texture, aroma (volatile compounds) and taste (sweet, sour, salty and bitter sensations), as well as between the sensory perceptions and the acceptability for the consumer [57].

Gum Arabic can also form a stable cloud in the drink, imitating the effect of added fruit pulps and juices. Gum Arabic is used increasingly as a source of soluble fiber in low-calorie and dietetic beverages. In powdered beverage mixes, gum Arabic is added to produce the same opacity, appearance, mouth feel and palatability as natural fruit juices [58].

Gum Arabic is known by the worldwide food, beverage and pharmaceutical industry as a versatile additive with polyvalent functions: Protective colloid, film-building and coating agent, encapsulating agent, oxidation inhibitor, stabilizer, emulsifier, texturant, clouding and clarifying agent, food adhesive. More recently, western countries discovered that acacia gum is also a dietary fiber with very interesting nutritional properties [59].

Table 7: Analysis of variance for organoleptic evaluation of pomegranate juice.

Samples	Taste	Color	Flavor	Texture	Overall acceptability
Pomegranate juice free	8.95 ±0.21	8.86 ±0.25	8.88 ±0.17	8.72 ±0.24	8.85 ±0.22
Pomegranate juice A	8.64 ± 0.33	8.64 ± 0.38	8.56 ± 0.34	8.53 ± 0.32	8.61 ± 0.32
Pomegranate juice B	8.48 ± 0.39	8.64 ± 0.38	8.28 ± 0.43	8.48 ± 0.43	8.29 ± 0.21
Pomegranate juice C	7.53 ± 0.55	8.58 ± 0.43	7.89 ± 0.53	8.36 ± 0.51	8.09 ± 0.45
Pomegranate juice D	5.32 ±0.12	7.78 ±0.26	6.75 ±0/24	6.25 ±0.35	6.53 ±0.37

Conclusion:

Low protein and minerals as P and K consumption diets should take in our consideration for the rats suffering from CKD. Also, the using of gum Arabic is considered cheaper and healthy safe compared with drugs used in treatment of chronic kidney diseases. Using of the GA in the daily diets of both healthy and CKD rats is recommended, which have the efficiency to reduce the serum urea, creatinine, potassium, calcium and phosphorus, with the improving of the BWG. Finally, paying attention in the future to carry out more and more research in the area of GA and extended its applications in human diets, industrial and medical applications such kidney diseases patients instead of the chemicals used which have induced healthy hazards and side effects for the human being.

REFERENCES

[1] Harambat, J., K.J. van Stralen, J.J. Kim and E.J. Tizard, 2012. Epidemiology of chronic kidney disease in children. Pediatr Nephrol., 27: 363-373.
[2] Snyder, S. and B. Pendergraph, 2005. Detection and evaluation of chronic kidney disease. *Am Fam Physician,* 72: 1723-1732.
[3] Levey, A.S., k. Eckardt, Y. Tsukamoto, A. Levin, J. Coresh, J. Rossert, D. Zeeuw, T.H. Hostetter, N. Lameire, G, Eknoyan, 2005. Definition and classification of chronic kidney disease: a position statement from Kidney Disease: Improving Global Outcomes (KDIGO). Kidney Int 67: 2089-2100.
[4] Cibulka, R., J. Racek and E. Vesela, 2005. The importance of L-carnitine in patients with chronic renal failure treated with hemodialysis (in Czech). Vnitr Lek, 51: 1108-1113.
[5] Gal-Moscovici, A. and M.S. Sprague, 2007. Role of Vitamin D Deficiency in Chronic Kidney Disease. J. of Bone and Mineral Research, 22(2): 91-94.
[6] National Kidney Foundation, 2004. K/DOQI, clinical practice guidelines for bone metabolism and disease in chronic kidney disease, guideline 7. 2004. Am J Kidney Dis 43:S1-S290, (suppl 1)
[7] Canadian Diabetes Association, 2008. Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. Canadian J. of Diabetes, 32(1): 65-71.
[8] National Kidney Foundation, 2003. K/DOQI Clinical Practice Guidelines for Bone Metabolism and Disease in Chronic Kidney Disease. American Journal of Kidney Diseases, 42(4): 70-77
[9] Suliman, M.O., 2011. The Darfur Conflict : Geography or Institutions. New York: Routledge. ISBN 978-0-415-88598-0.
[10] Al-Mosawi, A.J., 2004. Acacia gum supplementation of a low-protein diet in children with end- stage renal disease. Pediatr. Nephrol., 19(10): 1156-1159.
[11] Nasir, O., K. Wang and M. Föller, 2010. Downregulation of angiogenin transcript levels and inhibition of colonic carcinoma by Gum Arabic (Acacia senegal). Nutr Cancer, 62(6): 802-810.
[12] Trommer, H. and R.H. Neubert, 2005. The examination of polysaccharides as potential antioxidative compounds for topical administration using a lipid model system. *International Journal of Pharmaceutics,* 298(1): 153-163, ISSN: 0378-5173.
[13] Ali, B.H. and M.S. Al Moundhri, 2006. Agents ameliorating or augmenting the nephrotoxicity of cisplatin and other platinum compounds: a review of some recent research. Food and Chemical Toxicology, 44(8): 1173-1183, ISSN: 0278-6915.

[14] Glover, D.A., K. Ushida, A.O. Phillips and S.G. Riley, 2009. Acacia (sen) SUPERGUMTM (Gum arabic): An evaluation of potential health benefits in human subjects. Food Hydrocolloids, 23(8): 2410-2415, ISSN: 0268-005X.
[15] Ali, B.H., S. Al-Salam and I. Al-Husseni, 2010. Effects of Gum Arabic in rats with adenine-induced chronic renal failure. Exp Biol Med (Maywood), 235(3): 373-382.
[16] Yokozawa, T., P.D. Zheng, H. Oura and F. Koizumi, 1986. Animal model of adenine-induced chronic renal failure in rats. Nephron, 44: 230-234.
[17] Ali, B.H., I. Al-Husseni, S. Beegam, A. Al-Shukaili, A. Nemmar, S. Schierling, N. Queisser and N. Schupp, 2013. Effect of gum arabic on oxidative stress and inflammation in adenine-induced chronic renal failure in rats. PLoS One 8: e55242.
[18] Nasir, O., A.T.R. Umbach, Rexhepaj, T.F. Ackermann, M. Bhandaru, A. Ebrahim, F. Artunc, D.S. Kempe, G, Puchchakayala, B. Siraskar, M. Foller, A. Saeed and F. Lanf, 2012. Effects of gum arabic (*Acacia senegal*) on renal function in diabetic mice. Kidney Blood Press Res., 35: 365-372.
[19] Li, Y., C. Guo, J. Yang, J. Wei, J. Xu and S. Cheng, 2006. Evaluation of antioxidant properties of pomegranate peel extract in comparison with pomegranate pulp extract. Food Chemistry, 96: 254-260.
[20] Reddy, M., S., Gupta, M., Jacob, S.Khan and D. Ferreira, 2007. Antioxidant, antimalarial and antimicrobial activities of tannin-rich fractions, ellagitannins and phenolic acids from *Punica granatum L*. Planta Medica., 73: 461-467.
[21] Al-Zoreky, N.S., 2009. Antimicrobial activity of pomegranate (*Punica granatum* L.) fruit peels. International J. Food Microbiology, 134: 244-248.
[22] Naveena, B.M., A.R. Sen, R.P. Kingsly, D.B. Singh and N. Kondaiah, 2008. Antioxidant activity of pomegranate rind powder extract in cooked chicken patties. Inter. J. Food Science Techn., 43: 1807-1812.
[23] Omer, E.A., I.A.M. Ayed and S.M.A. El Badwi, 2013. Effect of gum arabic on nephrotoxicity induced by *aristolochia bracteata* in rats. Sch. Acad. J. Biosci., 1(7): 377-380.
[24] AOAC, 2010. Official Methods of Analysis of Association of Official Chemists. 18th Ed., Washington, D.C., USA.
[25] Anderson, D.M.W. and I.C.M. Dea, 1969. Light-scattering studies of *Acacia* gum exudates. Carbohydrate Research, 10(1): 161-164.
[26] Karamalla, K.A., N.E. Siddig and M.E. Osman, 1998. Analytical data for Acacia senegal gum samples collected between 1993 and 1995 from Sudan. Food Hydrocolloids, 9: 1-6.
[27] Tietz, N.W., 1976. Fundamental of Clinical Chemistry. Philadelphia, W.B. Saunders, pp: 243.
[28] Belfied, A. and D.M. Goldberg, 1971. Human serum glucose-6-phosphatase activity: confirmation of its presence and lack of diagnostic value. Enzyme, 12: 561-265.
[29] Barham, D. and P. Trider, 1972. Enzymatic determination of serum uric acid. Analst, 97: 142-145.
[30] Bartles, H., M. Bohmer, and C. Heirli, 1972. Creatinine standard and measurement of serum creatinine with picric acid. Clin. Chem. Aceta., 37: 193-196.
[31] Fawcett, J.K. and J.E. Soctt, 1960. Enzymatic colorimetric method of urea. J. Cline, Path., 13: 156-159.
[32] Doku, G.N. and V.P.Y., Gadzekpo, 1996. Simultaneous determination of lithium, sodium and potassium in blood serum by flame photometric flow-injection analysis. Elsevier, 43(5): 735-739.
[33] Paglia, D.E. and W.E. Valentine, 1967. Studies on the quantitative and qualitative characterization of erythrocyte glutathione peroxidase. J. Lab. Clin. Med. 1: 158-169.
[34] Aebi, H.E., 1984. Catalase in vitro. Methods of Enzymol., 105: 121.
[35] Aebi, A.H., 1983. Methods of Enzymatic Analysis (Bergmeyer, H. U., Ed.) 3rd ed. Vol 3, Verlag Chemie, Deerfield Beach, FL, pp: 273-286.
[36] Andress, E.L. and A.H. Judy, 1999. So Easy to Preserve, 4th Ed. Cooperative Extension Service, University of Georgia. Athens GA.
[37] Tehranifar, A., M. Zarei, Z. Nemati, B.I. Esfandiyar and M.R. Vazifeshenas, 2010. Investigation of physico-chemical properties and antioxidant activity of twenty Iranian pomegranate (*Punica granatum* L.) cultivars. Sci. Hortic., 126: 180-185.
[38] SAS, 2004. Statistical Analysis System. SAS User's Statistics SAS Institute Inc. Editors, Cary, NC.
[39] Dauqan, E. and A. Abdullah, 2013. Utilization of gum Arabic for industries and human health. American Journal of Applied Sciences, 10(10): 1270-1279.
[40] Abdul-Hadi, A.H., A.E. Mahmoud and H.M. AbdelWahab, 2010. Effect of gum Arabic on coagulation system of albino rats. Int. J. Pharm. Tech. Res., 2: 1762-1766.
[41] Nasir, O., A. Ferruh, S. Amal, M.A. Kambal and K. Hubert, 2008. Effects of gum Arabic (Acacia senegal on water and electrolyte balance in healthy mice. J. Renal Nutr., 18: 230-238.
[42] Abd-Razig, N.M., M.K. Sabahelkhier and O.F. Idris, 2010. Effect of gum Arabic (Acacia senegal, L. Willd) on lipid profile and performance of laying hens. J. Applied Biosci., 32: 2002-2007.

[43] Sabah El-Kheir, M.K., A.A. Yagoub and A.A. Abu Baker, 2008. Emulsion-Stabilizing effects of gum from *Acacia senegal* (L) Willd. The role of Quality and grade of gum, oil type, Tempereture, stirring time and concentration. Pakistan Journal of Nutrition, 7(3): 395-399.
[44] Montenegro, M.A., M.L. Boiero, L. Valle and C.D. Borsarelli, 2012. Gum Arabic: More Than an Edible Emulsifier, In Tech Europe, University Campus STeP Ri, Slavka Krautzeka 83/A, 51000 Rijeka, Croatia
[45] Mohammed, N.M., 2013. Chemical and technological studies on some food products supplemented with gum arabic. M.Sc. Thesis, Faculty of Home Economics, Minufiya University Shebin El-Kom, Egypt.
[46] NKUDIC, National Kidney and Urologic Diseases Information Clearinghouse, 2012. Khan IH, Catto GR, Edward N, MacLeod AM: Death during the first 90 days of dialysis: A case control study. Am J Kidney Dis 25: 276-280.
[47] Perneger, T.V., K. Whelton, P. Klag and J. Michael, 1994. "Risk of Kidney Failure Associated with the Use of Acetaminophen, Aspirin, and Nonsteroidal Antiinflammatory Drugs". New England Journal of Medicine 331 (25): 1675-9.
[48] Bennett, P.H., C.E. Mogensen and W.F. Keane, 1995. Prevention of diabetic renal disease with special reference to micro albuminuria. Lancet, 346: 1080-4.
[49] Pagana, K.D. and T.J. Pagana, 1997. Mosby's diagnostic and laboratory test references. 3 rd ed., Mosby-year Book, Inc., New York.
[50] Bliss, D.Z., T.P. Steinr, C.R. Schleife and R.G. Settle, 1996. Supplementation with gum Arabic fiber increases fecal nitrogen excretion and lowers serum urea nitrogen concentration in chronic renal failure patients consuming a low-protein diet. Am J Clin Nutr, 63: 392-398.
[51] Abd-ELFattah, M.A., A.T. El-Shahat, M.E. Ahmad, A.A. Mosaad, M.O. Mohamed and E.S. Gamal, 2006. Discriminant function based on hyaluronic acid and its degrading enzymes and degradation products for differentiating cirrhotic from non-cirrhotic liver-diseased patients in chronic HCV infection. Clinica. Chimica. Acta. 369: 66-72.
[52] Kuntz, E., 2001. Laboratory diagnostics. *In*: Kuntz E, Kuntz HD, eds. Hepatology, principles andpractice. Heidelberg: Springer –Verlag, pp: 78-112.
[53] Robert, T., K. Abbas and R. John, 2008. Chronic Kidney Disease and Its Complications. Prim Care Clin Office Pract, 35: 329-344.
[54] Ammar, T., 2011. Immediate surgery reduced long-term risk for nonperioperative stroke in severe asymptomatic carotid artery stenosis. Ann Intern Med., 154 (4): JC2-7.
[55] Winston, G.W. and R.T. Di Giulio, 1991. Prooxidant and antioxidant mechanisms in aquatic organisms. Aquat. Toxicol., 19: 137-161.
[56] Čolarić, M., R. Veberič, F. Štampar and M. Hudina, 2005. Evaluation of peach and nectarine fruit quality and correlations between sensory and chemical attributes. Journal of the Science of Food and Agriculture, 85: 2611-2616.
[57] Escribano, S., F.J. Sanchez and A. Lazaro, 2010. Establishment of a sensory characterization protocol for melon (Cucumis melo L.) and its correlation with physical-chemical attributes: indications for future genetic improvements. Eur Food Res Technol., 231: 611-621.
[58] Wyasu, G. and N.Z.J. Okereke, 2012. Improving the film forming ability of gum Arabic. J. Nat. Prod. Plant Resour, 2: 314-317.
[59] NGARA, 2005. Network for Natural Gums and Resins in Africa, Publication Series 3, Kenya Forestry Research Institute, Nairobi, Kenya.