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# Correlation of Gum Acacia with Serum Electrolytes among Patients with Renal Disease

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## Abstract

**Introduction:** Gum arabic acacia is a complex polysaccharide, aggregates of sugars and hemicelluloses composed of Arabic acid nucleus, it is found in nature as slightly acidic calcium, magnesium, potassium or sodium salt and there is different metal ions present in gum arabic molecules. Chemically, it is an arabinogalactan-protein complex composed by weight of 17-34% arabinose, 32-50% galactose, 11-16% rhamnose, 13-19% glucuronic acid and 1.8-2.5% protein. Renal diseases are manifested in alteration in serum Electrolytes. Disturbance in Ca++, K+, Na+ and Po4 level is found to be very common among these patients. This study aimed to investigate the role of gum arabic in monitoring the serum level of these electrolytes in different centers for kidney diseases in Khartoum.

**Methodology:** It is a randomized control trial study, it was performed using volunteers with different Kidneys function with six months past history records. Up grading dose of 10,15,20,25 grams of gum dissolved in 250mls drinking water to be taken daily morning, for duration of 16- 18 weeks with interval every four weeks for every dose. Blood samples were taken for electrolytes analysis first as a control, and after every dose before starting the next one.

**Results:** The electrolytes levels showed biological rearrangement optimized referenced readings, at a dose range from 20-25gm. (Na 137.86 +/-2.54 before, 135.00+/-2.04 after with P-value 0.003, K 4.1571 +/-0.7377 before, 5.2500+/-0.4034 after, with P-value 0.000, Ca 8.8857 +/- 0.5531 before, 9.7214 +/-0.3786 after, with P-value0.000, Po4 3.6286 +/- 0.5622 before, 4.5357+/- 0.4199 after, with P-value 0.000).

**Conclusion:** There is a significant correlation between Gum acacia and serum electrolytes as monitoring depending on the Gum components ratios with stable electric neutrality.

**Keywords:** Gum Acacia; Serum Electrolytes; Renal Disease

## Literature Review

Electrolytes (Na, K, Ca, PO4) disturbance is very clear in patients with renal disease, specifically disturbance of Ca and PO4 was reported in patients with reduced glomerular filtration rate [1]. The kidney also plays a vital role in maintaining the normal serum level of potassium (K), so one of the dangerous alterations in renal diseases is the disturbance in serum K+. Hyperkalemia is a grave finding which is frequently encountered in poorly managed patients with renal disease. Similarly excess phosphorus is removed from the body through the urine by the kidney and so high serum levels of PO4 are sequence of kidney diseases [2]. (Helen Dorrough. Potassium, Phosphorus and the Dialysis Diet. Available in DaVita.com > Kidney disease education > Diet and Nutrition > Diet Basics > Potassium, Phosphorus and the Dialysis Diet). Some studies reported elevated serum PO4 in patients with chronic renal failure and gum arabic administration was associated with lowering the serum level to normal [3]. Gum arabic is proved to be effective in improving the renal profile in patients with kidney disease [4].

Gum Arabic (Acacia Senegal) is a branched-chain, complex polysaccharide, either neutral or slightly acidic so found as a complex mixture of calcium, magnesium and potassium salt of a polysaccharide acid or as a complex branched polysaccharide

that contains D- galactose, L-rhamnose, D-glucuronic acid and L-arabinose residues. These sugars constituents of gum Arabic are the same but composition and molecular weight of the gum varies from species to species in the range of 260,000 to 1,160,000 [5]. The backbone is composed of 1, 3-linked β-D-galactopyranosyl units. The side chains are composed of two to five 1, 3-linked β-D-galactopyranosyl units, joined to the main chain by 1, 6-linkages [6]. Chemically, it is an arabinogalactan-protein complex composed by weight of 17-34% arabinose, 32-50% galactose, 11-16% rhamnose, 13-19% glucuronic acid and 1.8-2.5% protein.

Nature has provided us a wide variety of materials to help improve and sustain the health of all living things either directly or indirectly. For centuries man has made effective use of materials of natural origin in the medical and pharmaceutical field. In recent years there have been important developments in different dosage forms for existing and newly designed drugs and natural products, and semi-synthetic as well as synthetic excipients often need to be used for a variety of purposes but today, the whole world is increasingly interested in natural drugs and excipients [7]. Gums are the one of widely used natural materials for conventional and novel dosage forms. Tens of thousands of people worldwide depend on the collection of gums as an income. Equally, many millions of people around the world make use of these products in their everyday life.

Gum arabic is a complex mixture of arabinogalactan oligosaccharides, polysaccharides, and glycol proteins. It is a branched neutral or slightly acidic substance. The chemical composition and the composition of the mixture can vary with the source, climate, season, age of trees, rainfall, time of exudation, and other factors. The backbone has been identified to consist of b-(1→3)-linked d-galactopyranosyl units. The side chains are composed of two to five b-(1→3)-linked d-galactopyranosyl units, joined to the main chain by 1,6-linkages.

Both the main and the side chain contain units of:

A-l-arabinofuranosyl,

A-l-rhamnopyranosyl,

B-d-glucuronopyranosyl, and

4-O-methyl-b-d-glucuronopyranosyl. The latter two usually occur preferably as end units [8].

Depending on the source, the glycan components of GA contain a greater proportion of L-arabinose relative to d-galactose (Acacia seyal) or d-galactose relative to l-arabinose (Acacia senegal). The gum from Acacia seyal also contains significantly more 4-O-methyl-d-glucuronic acid but less l-rhamnose and unsubstituted d -glucuronic acid than that from Acacia Senegal [9]. GA has a complicated molar mass distribution. Some authors report a mixture of lower molar mass polysaccharide (M w » 2.5×105 for the major component) and higher molar mass hydroxyproline-rich glycoprotein M w»2.5×106 for the minor component [10].

Others describe three fractions arabinogalactan (88.4%) with 3.8×105g/mol, arabinogalactan protein complex (10.4%) with 1.45×106g/mol, and a low molar mass glycoprotein (1.2%) with 2.5×105g/mol. Because it is a mixture, which varies with source, the exact chemical composition and molecular structures are still debated. Physico-chemical Characteristics of Gum Arabic.

Gum arabic is odorless, colorless, tasteless, and does not affect the odor, color, and taste of the system to which it is added. It is highly soluble in water and dissolves in both cold and hot water with concentrations up to 50wt%. The solutions exhibit Newtonian behavior at concentrations up to 40wt% and become pseudo plastic at higher concentration. The viscosity of solutions varies strongly with the GA type, pH, and ionic strength. Maximum viscosity is achieved between pH 6 and 7. GA acts as protective colloid and excellent emulsifier. The adhesive property is not related to the viscosity [11]. GA was also found to be a useful prebiotic, which promotes beneficial physiological effects [12].

However, the name is also used for other gums produced by other Acacia species [13]. Despite there being more than 500 species of acacia trees, most commercial GA is produced from Acacia Senegal and Acacia seyal which are grown commercially throughout the Sahel from Senegal and Sudan to Somaliland.

## Objectives

a) To determine serum level of sodium, calcium, phosphorus, and potassium in patients with kidney disease.

b) To investigate the correlation of gum arabic with serum electrolytes in patients with kidney diseases.

## Rationale of the Study

A reduction of serum urea due to increased bacterial nitrogen excretion in the faeces was reported almost 20 years ago. In favor of a positive effect, work performed over 10 years ago in Khartoum, suggested beneficial effect on blood biochemistry following dietary supplementation with 50g/day in patients with CKD [14]. A similar finding has recently been reported from the Central Sudan [15].

It should be emphasized however that these findings are not universally accepted and shortfalls in study design as well as studies with less dramatic effects on renal function have recently been highlighted [16]. To date, although there are numerous health claims which are made for dietary supplementation with Gum Arabic, however these are not widely accepted in clinical practice. It is clear that a structured program of clinical studies as a "proposed clinical trial protocol of Gum Arabic use in chronic kidney disease". The dose selected to be used in the trial will be the least effective dose of Gum Arabic that lowers the


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serum indoxylsulphate and increases the SCFAs concentrations, supported by good mechanistic basic science is now needed to Exploring the potential health benefits of Gum Arabic, to re-establish a medical application for Gum Arabic.

## Materials and Methodology

**Material:** Gum Acacia from Kordofan region in west Sudan was collected and prepared as required for usage in this study. Microbial test was done to get sure free of microbes (Table 1).

**Type of the study:** It is a Randomized clinical trial study.

**Place of the study:** In Khartoum different Known Kidney disease centers, Salma center, Ibn Seena, Ahmed Gasim and Arif. These are the senior referral hospitals in Sudan. Patients from all over the country are used to be referred to these centers; hence a sample recruited from these centers is considered representative to Sudan population.

**Population of the study:** Call for participation was announced in the nominated hospitals. Volunteers with different stages of renal impairment for the past six months were reported. Those fulfilled the inclusion criteria were approached and asked to participate. A written consent was signed by the patients themselves.

**Exclusion criteria:** patients with stage IV kidney disease, patient on dialysis and renal transplanted patients and pregnant ladies.

**Dosage of gum arabic:** The minimal lethal dose was determined as follows

a. Different weights of gum arabic in instant soluble form were dissolved into 250 mls of drinking water.

b. The weights were 10 Gms, 15 Gms 20 Gms and 25 Gms.

c. All the volunteers were started with the 10gm in 250ml water taken for 4 weeks.

d. The dose was given orally in early morning on daily basis. It was then upgraded to 15 gms, 20 and finally to 25 gms each for 4 weeks interval.

e. 3mls of venous blood was collected in tube before the first dose to determine the baselines electrolytes levels.

f. Blood samples were collected at the end of last week for each dose interval.

g. All the samples were analyzed for serum electrolytes in ALBURJ lab in the center of Khartoum city.

h. The data was computed in SPSS version 20 and ANOVA was obtained.

## Result

The results of this study were presented in a form of tables and figures. (Table 1) showed the results of microbial contamination test of the purified gum. It displayed no growth to all parts of the tested bacteria. (Table 2) described the demographic data of the study population. (Table 3) shows the significance of serum electrolytes before and after administration of gum arabic in comparison to standard reference values.

**Table 1:** Microbial contamination test of purified gum acacia.

| Gender | Number | Average Age in years +/- SD |
|---|---|---|
| male | 10 | 53 +/- 8.5 |
| female | 14 | 58 +/- 14.3 |
| Total | 24 | |

**Table 2:** Distribution of the study Population by gender and age in years.

| Gender | Number | Average Age in years +/- SD |
|---|---|---|
| male | 10 | 53 +/- 8.5 |
| female | 14 | 58 +/- 14.3 |
| Total | 24 | |

## Statistical Data Analysis

Were done based on mean +/- standard deviation (SD) using ANOVA statistical one way to investigate the variance significance. In all analysis of data generated from in vivo studies the probability p-value 0.05 was considered as appoint for significance. (Individual 95% CIs for Mean Based Pooled St-Dev). (Table 3), (Figures 1-4).

**Table 3:** Significance of serum electrolytes before and after administration of gum Arabic in comparison to standard reference values.

| Electrolytes | Reference value | Before GA (mean +/- SD) | After 25 grms GA (mean +/- SD) | P- value |
|---|---|---|---|---|
| Na | 135 -145 | 137.86 +/-2.54 | 135.00+/-2.04 | 0.003 |
| K | 3.5 -5.0 | 4.1571 +/-0.7377 | 5.2500 +/-0.403 | 0.000 |
| PO4 | 2.5 -3.5 | 3.6286+/- 0.5622 | 4.5357+/- 0.4199 | 0.000 |
| Ca | 8.0 -10.0 | 8.8857+/- 0.5531 | 9.7214 +/-0.3786 | 0.000 |


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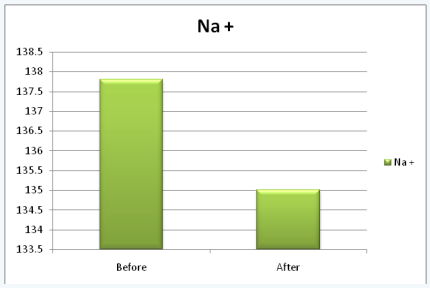


**Figure 1:** Decline of serum Sodium after 25 grams gum arabic administration.
(mean +/- SD 137.86 +/-2.54 before), and (mean +/- SD 135.00+/-2.04 after)

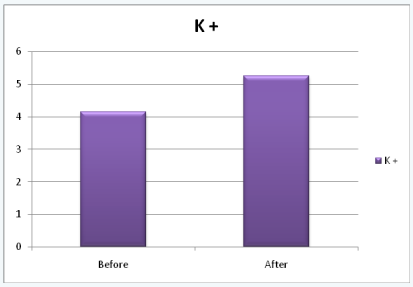


**Figure 2:** Increased serum Potassium level after administration of 25grams gum arabic.
(mean +/- SD 4.1571 +/-0.7377 before) and (mean +/- SD 5.2500 +/-0.403 after)

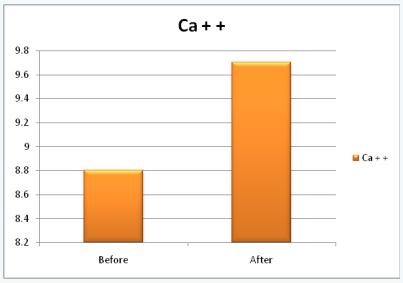


**Figure 3:** Increased serum Calcium level after administration of 25 grams gum Arabic.
(mean +/- SD 8.8857+/- 0.5531 before) and ( mean +/- SD 9.7214 +/-0.3786 after)

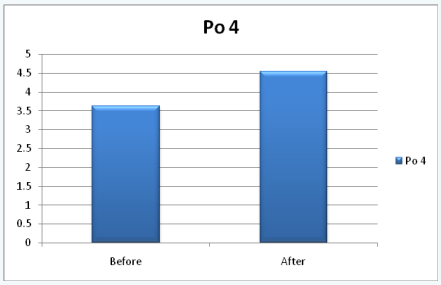


**Figure 4:** Increased serum phosphorus level after administration of 25 grams gum Arabic.
(mean +/- SD 3.6286+/- 0.5622 before) and (mean +/- SD 4.5357+/- 0.4199 after)

## Discussion

Alteration of serum electrolytes in patients with renal diseases is well documented in the literature. Gum arabic is frequently used in kidney disease and it showed positive effects in restoring the normal levels of electrolytes in these types of patients. The current study focused on the commonly observed disturbance of electrolytes in patients with kidney disease. The study showed significant association with Gum arabic administration and adjusting the level of serum sodium to normal values (p value 0.003). Lowering below the normal level was not reported and this was evident by continuity of administration of gum arabic for 18 weeks which reported stable readings without hyponatreimia.

On the other hand drop in the serum levels of potassium, calcium and phosphorous, were reported as ominous findings in renal impairment. Correlation with gum arabic administration and correction of these electrolytes level was clearly obtained.

Controversial readings were reported in relations to alterations of phosphorus level. Some studies reported elevated serum PO4 in patients with chronic renal failure and gum arabic administration was associated with lowering the serum level to normal [17]. This may agree with our findings in that regardless to the type of alteration in PO4, gum arabic was associated with restoration to normal level.

The study showed significant elevation of the serum K in such type of patients to reach the normal level (p -value 0.000). Potassium is important in controlling blood pressure because potassium lessens the effects of sodium, and hence control the muscles contractibility [18].

Current study showed significant association with Gum arabic administration and elevating the level of serum calcium to normal value (0.000). Elevation above the normal level was not reported which evident by continuity of administration of gum arabic for 18 weeks which reported high readings without hyper calcium.

Current study showed significant association with Gum arabic administration and elevating the level of serum phosphorus to normal value (0.000). Elevation above the normal level was not reported which evident by continuity of administration of gum arabic for 18 weeks which reported high readings without hyper phosphorus.

An electrolyte is a substance that produces an electrically conducting solution when dissolved in water. Electrolytes carry a charge and are essential for life. Our muscles and neurons are sometimes referred to as the “electric tissues” of the body. They are reliant on electrolyte movement between extracellular, interstitial and intracellular fluid (fluid inside, outside or between cells).


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A muscle contraction needs calcium (Ca2+), sodium (Na+) and potassium (K+) to be present. Wrong electrolyte levels can lead to either weak muscles, or muscles that contract too severely. To maintain constant electrolyte concentrations in our body fluids, these electrolytes must be replaced. Fresh fruits, vegetables and gum acacia were good sources of sodium and potassium and replace lost electrolytes. Excess electrolyte levels in our blood are filtered out by our kidneys, so one of causes of electrolyte imbalance is the Kidney disease.

## Conclusion

Gum arabic acacia, plays novel effect on electrolytes balance in blood serum of kidney disease patents depending on the Chemical component Description of Gum Arabic which acting as a monitor for those subjects of these study, hence it decrease the Na+ acidic salt in the blood and increase others K+, Ca++, and Po4 up to the standard reference values. Monitoring and rearrangement takes place depending on stability of the four elements complex.

Water and electrolytes are absolutely two of the most critical components of normal, physiological function. Without a correct balance of fluid and electrolytes, the cells of our body lack the essential electrical conductivity necessary for cellular energy production.

This data sheds light on a new era of electrolytes management that worth further studies. Hence long duration clinical trial (more than 4 months) will be beneficial to assess the sustainability of the optimum values and its advantages on clinical events and kidney disease severity.

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