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# THE EFFECT OF GUM ARABIC ORAL TREATMENT ON THE IRON AND PROTEIN STATUS IN CHRONIC RENAL FAILURE PATIENTS UNDER REGULAR HEMODIALYSIS IN CENTRAL SUDAN

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**Objective** To assess the effect of gum arabic (Acacia Senegal) oral treatment on the iron and protein status in chronic renal failure patients.

**Material and Methods** Thirty-six chronic renal failure (CRF) patients (under regular hemodialysis), and 10 normal subjects participated in this study. The patients were randomly allocated into the following groups: Group A (n=12): CRF patients under low protein diet (LPD) (less than 40 gram/day), and gum arabic (50 g/day) treatment; Group B (n=14): CRF patients under LPD, gum arabic, iron (ferrous sulphate 200 mg/day) and folic acid (5 mg/day) treatment; Group C (control group, n=10): CRF patients under LPD, iron and folic acid treatment; Group D (n=10): normal volunteers who were kept on normal diet beside a daily dose of 50 gm gum arabic. Each of the above treatments was continued for three consecutive months. Predialysis blood samples were collected from each subject before treatment, and twice per month for three months. Hemoglobin (Hb), hematocrit, total protein, albumin, globulin and 24-hour urine volume as well as serum iron, total iron-binding capacity (TIBC), transferrin saturation, packed cell volume (PCV) and, mean corpuscular hemoglobin concentration (MCHC) were determined.

**Results** Following administration of gum arabic oral treatment for three months, serum iron increased by 5.85% and 4.81% for groups A and B, respectively. These increases were significantly different from the baseline ($P<0.05$), and control group C ($P<0.01$). TIBC was significantly decreased in group A (4.44%) and in group B (4.31%) as compared with the baseline and control group C ($P<0.05$). Transferrin saturation was significantly increased by 7.77%, and 9.59% for groups A and B, respectively, compared with the baseline ($P<0.05$) and control group C ($P<0.01$). Hb, PCV, MCHC, serum total protein, albumin and globulin, and 24-hour urine volume showed no statistically significant differences from the baseline and control groups.

**Conclusion** The improvement in iron status due to oral administration of gum arabic could reduce the need for oral iron prescription.

**Key Words** gum Arabic, renal failure, hemodialysis, Sudan

## INTRODUCTION

Chronic renal failure (CRF) represents one of the most expensive and rapidly growing demands on the health-care system of developed and developing countries. Its incidence appears to be increasing, particularly in some developing countries. In view of the relatively poor status of the health-care system in the developing world, there is an obvious need for the reduction of the cost of dialysis, treatment and transplantation operations.

Gum arabic is defined as the dried gummy exudates from the stems and branches of Acacia Senegal Wild, or other related African species of Acacia (Leguminosae). It is a complex of very high molecular weight acidic heteropolysaccharides. Acacia Senegal is a tree known as Hashab which is abundant in Sudan, especially in Kordofan state. The Sudanese normally consume gum arabic as crude or as food additive. It is considered a normal cheap foodstuff devoid of serious side

**Table 1:** Effect of Three Months Gum Arabic Treatment on Serum Iron, Total Iron Binding Capacity Concentration and Transferrin Saturation in Chronic Renal Failure Patients and Normal Subjects

| | Group A (gum only) | Group B (gum + iron) | Group C (iron only) | Group D (normal) (gum only) |
|---|---|---|---|---|
| Serum iron concentration (μg/dl) | | | | |
| - before treatment | 82.50 ± 21.90 | 88.93 ± 27.61 | 83.00 ± 25.73 | 75.50 ±12.12 |
| - after treatment | 87.33 ± 21.57 | 93.21 ± 26.32 | 80.20 ± 23.89 | 80.20 ± 9.93 |
| Difference from baseline | P < 0.05 | P < 0.05 | NS | P < 0.05 |
| Difference from control | P < 0.01 | P < 0.01 | | |
| Total iron-binding capacity concentr. (μg/dl) | | | | |
| - before treatment | 471.5 ± 116.86 | 480.7 ± 106.15 | 486.0 ± 94.42 | 307.0 ± 47.15 |
| - after treatment | 451.0 ± 115.20 | 460.0 ± 92.28 | 512.0 ± 101.36 | 294.0 ± 32.39 |
| Difference from baseline | P < 0.05 | P < 0.05 | NS | P < 0.05 |
| Difference from control | P < 0.05 | P < 0.05 | | |
| Transferrin saturation % | | | | |
| - before treatment | 17.50 ± 2.96 | 18.56 ± 4.59 | 16.94 ±3.12 | 25.43 ± 6.73 |
| - after treatment | 19.36 ± 4.40 | 20.34 ± 4.79 | 15.68 ±3.28 | 27.68 ± 5.08 |
| Difference from baseline | P < 0.05 | P < 0.05 | NS | P < 0.05 |
| Difference from control | P < 0.01 | P < 0.01 | | |

P < 0.05, P < 0.01 = statistically significant ; NS = statistically not significant

**Table 2:** Effect of Three Months Gum Arabic Treatment on Hemoglobin, Packed Cell Volume and Mean Corpuscular Hemoglobin Concentration in Chronic Renal Failure Patients and Normal Subjects

| | Group A (gum only) | Group B (gum + iron) | Group C (iron only) | Group D (normal) (gum only) |
|---|---|---|---|---|
| Hemoglobin concentration (g/dl) | | | | |
| - before treatment | 8.16 ± 1.49 | 8.76 ± 1.69 | 8.56 ± 1.69 | 11.33 ± 1.24 |
| - after treatment | 8.51 ± 2.04 | 8.83 ± 2.05 | 8.00 ± 1.77 | 11.77 ± 1.16 |
| Difference from baseline | NS | NS | NS | NS |
| Difference from control | NS | NS | | |
| Packed cell volume % | | | | |
| - before treatment | 24.25 ± 4.75 | 25.79 ± 6.27 | 25.20 ± 4.96 | 33.50 ± 3.63 |
| - after treatment | 25.17 ± 6.45 | 26.21 ± 4.89 | 22.40 ± 4.25 | 34.60 ± 3.27 |
| Difference from baseline | NS | NS | NS | NS |
| Difference from control | NS | NS | | |
| Mean Corpuscular Hemoglobin Concentr. % | | | | |
| - before treatment | 33.75 ± 1.17 | 33.39 ± 1.43 | 33.96 ± 0.72 | 33.82 ± 0.52 |
| - after treatment | 33.96 ± 1.18 | 34.34 ± 1.46 | 33.80 ± 1.64 | 34.01 ± 0.45 |
| Difference from baseline | NS | NS | NS | NS |
| Difference from control | NS | NS | | |

NS = statistically not significant

effects. A maximum acceptable daily intake of acacia as a food additive has not been specified, since it is not considered to represent a hazard to health[1].

In a single trial carried out by Bliss et al. in the US in 1996, gum arabic was shown to be effective in significantly mitigating some signs and symptoms in CRF patients[2]. The mechanism by which gum arabic ameliorates CRF is uncertain, however it has been reported to increase fecal nitrogen excretion and to decrease urea production and urea-nitrogen recycling[3]. In a study on animal models of experimental chronic renal failure it was found that consumption of a diet containing fermentable carbohydrates resulted in a greater fecal nitrogen excretion coupled with a reduction in serum urea concentration[4]. Bliss, in his study, noted that patients with chronic renal failure consuming a low-protein diet with 50 gram gum arabic/day had a better fecal nitrogen excretion and lower serum urea than patients consuming only a low-protein diet. Others, however, claim that oral treatment with gum arabic in an experimental model of CRF in rats does not yield any significant changes, neither in plasma concentration of urea or creatinine, nor in body weight loss[5].

Gum arabic is commonly prescribed for chronic renal failure patients in Sudan; it results in decreased uremia and reduces the frequency of dialysis from three to two sessions per week, hence improving the quality of life.[6]

The aim of the present work was to assess the effects of gum arabic treatment on the iron and protein status of CRF patients under regular hemodialysis.

## PATIENTS AND METHODS

The gum arabic powder was donated by the Gum Arabic Company, Khartoum, Sudan. Ferrous sulphate and folic acid tablets were obtained from the Pharmacy Administration, Ministry of Health, Gezira State, Sudan.

Thirty-six chronic renal failure (CRF) patients who were under regular hemodialysis treatment at the Gezira Dialysis Center, Wad Medani Teaching Hospital, Wad Medani, Sudan, between March and June 2001 were selected based on a questionnaire and clinical examination. Ten normal subjects participated as a control group. After explaining the purpose of this study, written consent was obtained from each patient. Patients with less than two hemodialysis sessions per week, patients under antibiotic treatment, patients receiving exogenous recombinant human erythropoietin (rHuEPO) and patients with a history of bleeding and/or blood transfusion three months prior to this study were excluded. The patients were randomly classified into three groups: Group A (n=12): CRF patients under low protein diet (LPD)(< 40 gram/day) and gum arabic (*Acacia Senegal* 50 g/day) treatment; Group B (n=14): CRF patients on LPD (< 40 g/day), gum arabic (50 g/day), iron (ferrous sulphate 200 mg/day), and folic acid (5 mg/day) treatment; Group C (n=10): CRF patients on LPD (< 40 gram/day), iron (ferrous sulphate 200 mg/day) and folic acid (5 mg/day) treatment. To study the effect of gum arabic on normal subjects, 10 normal volunteers (Group D) who consumed a normal diet and took a daily dose of 50 gram gum arabic participated in the study. Each of the treatments described above was continued for three months. The gum arabic solutions were prepared fresh every day by dissolving 50 gram gum arabic powder in a cup of water.

Blood samples (5 ml) were collected from each subject before admission to the study, and twice per month (predialysis) for three months (a total of seven samples). These samples were divided into two portions: The first portion consisting of 5 ml of venous blood was drawn in the first and seventh sample, transferred into vials coated with anticoagulant (EDTA) and used for the determination of Hb levels and hematocrit. The second portion (total of seven samples) was prepared and kept frozen at –20 C° for the analysis of serum iron, total iron binding capacity, total protein and albumin by using calorimetric methods. Capillary tubes (75 mm in length and 1 mm in diameter) and microhematocrit centrifuge were used for determination of packed cell volume (PCV) and the hematocrit value, respectively, while the mean corpuscular hemoglobin concentration (MCHC) was determined by the formula

$$MCHC = \frac{Hb(g/dl) \times 100}{Hematocrit}$$

The values reported are the mean±SD (standard deviation). The paired sample t-test was used for the evaluation of all parameters with respect to the significant difference from

**Table 3:** Effect of Three Months Gum Arabic Treatment on Serum Total Protein Concentration in Chronic Renal Failure Patients and Normal Subjects

| | Group A (gum only) | Group B (gum + iron) | Group C (iron only) | Group D (normal) (gum only) |
|---|---|---|---|---|
| Serum total protein concentration (g/dl) | | | | |
| - before treatment | 7.15 ± 0.73 | 6.83 ± 0.84 | 7.16 ± 0.87 | 6.85 ± 0.68 |
| - 15 days after treatment | 7.17 ± 0.92 | 6.83 ± 0.61 | 6.52 ± 0.58 | 6.84 ± 0.58 |
| - 1 month after treatment | 7.37 ± 0.86 | 6.69 ± 0.62 | 7.12 ± 1.12 | 6.89 ± 0.61 |
| - 45 days after treatment | 7.35 ± 0.91 | 7.23 ± 0.70 | 7.00 ± 0.46 | 6.79 ± 0.68 |
| - 2 months after treatment | 7.20 ± 0.82 | 7.26 ± 0.53 | 7.12 ± 0.29 | 6.82 ± 0.63 |
| - 75 days after treatment | 7.10 ± 0.79 | 7.03 ± 0.47 | 6.30 ± 1.02 | 6.85 ± 0.65 |
| - 3 months after treatment | 6.68 ± 0.68 | 7.17 ± 0.57 | 7.04 ± 0.41 | 6.83 ± 0.67 |
| Difference from baseline | NS | NS | NS | NS |
| Difference from control | NS | NS | | |

NS = statistically not significant

**Table 4:** Effect of Three Months Gum Arabic Treatment on Serum Albumin Concentration in Chronic Renal Failure Patients and Normal Subjects

| | Group A (gum only) | Group B (gum + iron) | Group C (iron only) | Group D (normal) (gum only) |
|---|---|---|---|---|
| Serum albumin concentration (g/dl) | | | | |
| - before treatment | 3.33 ± 0.49 | 3.20 ± 0.36 | 3.32 ± 0.22 | 3.82 ± 0.60 |
| - 15 days after treatment | 3.59 ± 0.60 | 3.35 ± 0.41 | 3.52 ± 0.23 | 3.73 ± 0.60 |
| - 1 month after treatment | 3.31 ± 0.95 | 3.39 ± 0.47 | 3.54 ± 0.24 | 3.76 ± 0.54 |
| - 45 days after treatment | 3.49 ± 0.54 | 3.39 ± 0.47 | 3.54 ± 0.24 | 3.76 ± 0.54 |
| - 2 months after treatment | 3.51 ± 0.51 | 3.49 ± 0.41 | 3.30 ± 0.30 | 3.79 ± 0.61 |
| - 75 days after treatment | 3.31 ± 0.31 | 3.59 ± 0.49 | 3.28 ± 0.32 | 3.78 ± 0.58 |
| - 3 months after treatment | 3.39 ± 0.33 | 3.55 ± 0.54 | 3.44 ± 0.25 | 3.78 ± 0.52 |
| Difference from baseline | NS | NS | NS | NS |
| Difference from control | NS | NS | | |

NS = statistically not significant

the baseline (levels before the treatment) and control group (C); $P<0.05$ was considered significant.

## RESULTS

Serum iron concentration (Table 1) was significantly increased in Group A (5.85%) and Group B (4.81%) as compared with baseline ($P<0.05$) and control group C ($P<0.01$). Serum iron was also significantly increased compared to the baseline in the normal subjects (6.23%) ($P<0.05$). The total iron-binding capacity showed a significant decrease by 4.44%, and 4.31% in Groups A and B, respectively, compared with the baseline and control group C ($p<0.05$ for both groups). Also, the normal subjects (group D) reported a significant ($P<0.05$) decrease in total iron-binding capacity after

**Table 5:** Effect of Three Months Gum Arabic Treatment on Serum Globulin Concentration in Chronic Renal Failure Patients and Normal Subjects

| | Group A (gum only) | Group B (gum + iron) | Group C (iron only) | Group D (normal) (gum only) |
|---|---|---|---|---|
| Serum globulin concentration (g/dl) | | | | |
| - before treatment | 3.82 ± 0.77 | 3.63 ± 0.96 | 3.84 ± 0.82 | 3.03 ± 0.60 |
| - 15 days after treatment | 3.58 ± 1.18 | 3.47 ± 0.69 | 3.00 ± 0.75 | 3.11 ± 0.56 |
| - 1 month after treatment | 3.62 ± 1.07 | 3.30 ± 0.82 | 3.76 ± 0.97 | 3.13 ± 0.59 |
| - 45 days after treatment | 3.86 ± 0.92 | 3.84 ± 0.64 | 3.46 ± 0.67 | 3.03 ± 0.59 |
| - 2 months after treatment | 3.36 ± 1.30 | 3.77 ± 0.70 | 3.82 ± 0.39 | 3.03 ± 0.56 |
| - 75 days after treatment | 3.80 ± 0.76 | 3.44 ± 0.59 | 3.02 ± 0.81 | 3.07 ± 0.58 |
| - 3 months after treatment | 3.29 ± 0.60 | 3.62 ± 0.64 | 3.60 ± 0.28 | 3.05 ± 0.60 |
| Difference from baseline | NS | NS | NS | NS |
| Difference from control | NS | NS | | |

NS = statistically not significant

**Table 6:** Effect of Three Months Gum Arabic Treatment on the 24-Hour Urine Volume in Chronic Renal Failure Patients and Normal Subjects

| | Group A (gum only) | Group B (gum + iron) | Group C (iron only) | Group D (normal) (gum only) |
|---|---|---|---|---|
| 24-hour urine volume (ml/24 h) | | | | |
| - before treatment | 463.92 ± 518.24 | 407.86 ± 374.77 | 294.00 ± 247.30 | 1114.00 ± 478.85 |
| - after treatment | 495.67 ± 545.91 | 438.79 ± 400.63 | 283.10 ± 234.44 | 1202.00 ± 462.02 |
| Difference from baseline | NS | NS | NS | NS |
| Difference from control | NS | NS | | |

NS = statistically not significant

three months of gum arabic treatment. Transferrin saturation increased after three months of gum arabic treatment by 7.77% in Group A, and 9.59% in Group B. These results indicate a significant difference from the baseline ($P<0.05$) and control group C ($P<0.01$). The normal subjects showed a similar significant difference from the baseline ($P<0.05$).

Hemoglobin concentration, packed cell volume (PCV) and mean corpuscular hemoglobin concentration (MCHC) did not change significantly in the different groups (Table 2).

As shown in Tables 3-5, the serum total protein, albumin and globulin levels showed no significant changes during the course of gum arabic treatment in all groups.

In the patients of Groups A and B the 24-hour urine volume increased by 6.84% and 7.58%, respectively; these increases were statistically not significant compared with the baseline and control group (Table 6).

## DISCUSSION

In this study serum iron concentration significantly increased in Groups A, B and D which is likely to be due to the iron content of gum arabic (128 µg/g of gum ash)[7]. In addition, the acidity of the gum arabic solution could

render the iron more bioavailable due to its more soluble ferrous form[8]. The lack of any further rise in the serum iron concentration of our Group-B patients despite their intake of additional oral iron supplementation favors this explanation.

This significant increase of iron absorption was accompanied by a significant decrease of total iron-binding capacity concentration and a significant increase of transferrin saturation.

There was no statistically significant difference in the hemoglobin, packed cell volume and mean corpuscular hemoglobin concentration in the anemic patients of group A and B when compared to the baseline and control group C. Anemia accompanying chronic renal failure is mainly due to deficient erythropoietin.

Gum arabic is neither absorbed by nor does it exert a toxic effect on the liver as reported by Ross et al.[10]. This can explain the lack of non-significant changes in serum total protein, albumin, and globulin levels during the course of gum arabic administration in our study, a finding that also matches with a study done in rats[9].

The increase in the 24-hour urine volume in Groups A, B and D was probably due to the increased fluid intake as a result of feeling thirsty after gum ingestion. In addition, gum arabic use eliminates an appreciable amount of protein metabolic waste products through the gut and hence leads to a reduced filtration load on the kidney.

From this study we conclude that an improvement of the iron status achieved by oral administration of gum arabic in patients with CRF could reduce the demand for therapeutic oral iron prescription.

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## RESUME


### L'effet du traitement oral par de la gomme arabe sur le statut martial et de protéinémie chez les patients en insuffisance rénale chronique sous hémodialyse régulière au Soudan centrale

**Objectif:** D'évaluer l'effet du traitement oral par de la gomme arabe (acacia Sénégal) sur le statut martial et de protéinémie chez les patients en insuffisance rénale chronique sous hémodialyse régulière. **Matériel et méthodes**: Trente-six patients en insuffisance rénale chronique (CRF) (sous hémodialyse régulière), et 10 sujets normaux ont participé à cette étude. Les patients ont été aléatoirement assignés dans les groupes suivants : Groupe A (n=12) : Les patients en CRF sous régime hypoprotei-

né (LPD) (moins de 40 gram/jour), et traitement par de la gomme arabe (50 g/j) ; Groupe B (n=14) : Patients en CRF sous LPD, gomme arabe, fer (sulfate ferreux 200 mg/j) et acide folique (5 mg/j); Groupe C (groupe témoin, n=10) : Patients en CRF sous LPD, fer et acide folique ; Groupe D (n=10) : volontaires normaux qui ont été gardés sous régime normal près d'une dose quotidienne de gomme arabe 50 mg. Chacun des traitements ci-dessus a été continué pendant trois mois consécutifs. Des échantillons de sang de pré dialyses ont été rassemblés de chaque sujet avant traitement, et deux fois par mois pendant trois mois. L'hémoglobine (Hb), l'hématocrite, la protéine totale, l'albumine, la globuline, et volumes d'urine de 24 heures ainsi que le dosage de fer serique, la capacité de la fer-agglutination (TIBC), la saturation de la Transferrine, la valeur de l'hématocrite (PCV) et la concentration de l'hémoglobine corpusculaire moyenne (MCHC) ont été recueillis. **Résultats:** Après administration du traitement oral de la gomme arabe pendant trois mois, le dosage de fer sérique a augmenté de 5.85% et de 4.81% pour les groupes A et B, respectivement. Ces augmentations étaient sensiblement différentes de la ligne de base ($P<0.05$) et groupe témoin C ($P<0.01$). La capacité de la fer-agglutination totale (TIBC) a été diminué considérablement en groupe A (4.44%) et en groupe B (4.31%) comme comparé avec la ligne de base et groupes témoins ($P<0.05$). La saturation de la Transferrine a été augmentée considérablement par 7.77%, et 9.59% pour les groupes A et B, respectivement, comparé avec la ligne de base ($P<0.05$) et le groupe témoin ($P<0.01$). La concentration en Hb, la PCV, la MCHC, les protéines sériques totales, l'albumine et la globuline, et le volume uriné de 24 heures n'ont montré aucunes différences statistiquement significatives de la ligne de base et du groupe témoin. **Conclusion** L'amélioration de la concentration en fer dû à l'administration orale de la gomme arabe pourrait réduire le recours au fer par voie orale.

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