# Decolourization of Gum Arabic using Activated Charcoal

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**Abstract**

This research work is aimed at decolourizing gum Arabic using activated charcoal so as to improve the quality of gum Arabic before the use of additives on the gum Arabic. The experiment was conducted on laboratory scale, the filter fixed bed method was used and the adsorbent (activated charcoal) is a granular of 500µm mesh size. The pH, viscosity and transmittance of each solution were measured before and after passing through the fixed bed of activated charcoal. The results showed that the pH increases from 4.58 to 5.70 and viscosity reduces from 3.75 to 1.85 for unsorted gum solution while pH increases from 4.40 to 5.60 for sorted gum solution. The transmittance values for both sorted and unsorted gum solution increase with increase in wavelength as shown in the results which means decolourization has taken place to a very large extent.

**Keywords**

Gum Arabic, Activated charcoal

## Introduction

Gum Arabic is usually coloured, and the colours present in the gum Arabic are usually referred to as impurities. Some of the causes of these colours may be due to the extraction method, storage atmosphere, temperature and climatic changes. The presence of these colours in the gum Arabic reduces the quality of the gum, as such; the need to remove these colours arises in order to improve the gum Arabic quality to an acceptable standard.

Decolourization simply means colour removal. To improve colour of gum Arabic solutions, the initial colour have to be removed with the aid of decolorizing agent which is the activated charcoal.

Activated charcoal is a charcoal that has been treated with oxygen to open up millions of tiny pores between the carbon atoms. Activated charcoal is employ as our colour removing agent (adsorbent) due to its economic advantage over other adsorbents, its availability, it chemical inertness towards most of our materials of construction and its un-interference with the chemical composition of the product.

The uses of gum acacia or gum Arabic date back to about 5000 years to the time of the ancient Egyptians, and it is the oldest and best known of all the natural gums. Among its many ancient applications, gum Arabic was used as a binder in cosmetics and inks.

Gum Arabic (Gum acacia Senegal) is defined as the dried exudates obtained from the stems and branches of Acacia Senegal or the related species of Acacia. it consists mainly of high molecular weight polysaccharides and their calcium, magnesium and potassium salts which on hydrolysis yield arabinose, galactose, rhanose and glucuronic acid. It is important to remember that a damage tree will give a larger yield of gum. Thus, the natives will cut and strip the bark from a tree and return later to remove the tears of gum that form in the wounds or scars. Within 3-8 weeks the gum will start to collect in the wound, but this depends on the weather conditions. Gum droplets are about 0.75-3 inches in diameter, and they gradually dry and harden on exposure to the atmosphere. A young tree will yield 400-7000g annually.

During the rainy season no gum is formed since the trees are in full bloom. After collection, the gum is brought from the farms to villages; from there it is transported to the market. In Sudan for instance, the gum is auctioned under government supervision and this usually sets the world price. When the gum is auctioned, there is basic cleaning process including sieving, hand selection and grading. The main purpose of this cleaning process is the removal of sand, tree bark, extraneous material and any adulteration with other gums.

Gum Arabic is highly nutritious. It is related that the Bushman Hottentots have been known in times of scarcity to support themselves on it for days. In many cases of diseases, it is considered that a solution of Gum Arabic may for a time constitute the exclusive drink and food of the patients (Glickman, 1969).

Gum Arabic is a dry gummy substance obtained from acacia Senegal and other Species of small acacia trees native to the arid regions of central and northern Africa. The gum is produced by tapping or cutting into the tree bark and allowing the gum to ooze out and collect in drops called tears. The tears are harvested after they harden.

Gum Arabic dissolves in water to form a viscous or gluey suspension used in candies and medicines in making adhesives, inks and papers and in printing and sizing textiles.

The best grades of gum are clear, white (bleached) and tasteless. “Sudan” (or Kordafan) and “Senegal” gum Arabic are chemically alike, differing only in their areas of origin (BeMiller and Whistler, 1973).

### *Types of Gum Arabic*

In Nigeria we have three types or grades of gum Arabic.

The grades are the handpicked selected type referred to as Grade one, cleaned type referred to as Grade two and the sifting and gum dust type referred to as grade three.

### *Uses of Gum Arabic*

By far gum Arabic is mostly used in the different sectors of the food industry. Other areas where gum Arabic is used are pharmaceuticals and the printing industry. The use of gum Arabic in non-food use has been estimated to grow about 4% (on volume basis) between 1988 and 1995.

In food products, gum Arabic is used as a functional ingredient, which means that the typical functions of gum Arabic are: Emulsifier, flavouring agent, humectants, thickener, surface-finishing agent and retards sugar crystallization.

In addition, gum Arabic has water solubility, is insoluble in alcohols and forms colourless, tasteless solutions.

The food applications of Gum Arabic have been developed from its unequalled combination of properties.

Emulsification, acid stability, low viscosity at high concentration, adhesive and binding properties and good mouth feel characteristics have been applied in five main food areas worldwide in descending order of importance which includes: Confectionary, beverages and emulsions, flavour encapsulation, bakery products and brewing (Duke, 1981).

***Activated Charcoal***

Activated charcoal is a charcoal that has been treated with oxygen to open up millions of tiny pores between the carbon atoms.

The use of special manufacturing techniques results in highly porous charcoal that has surface areas of 300-2000 square meters per gram. These so called active or activated charcoal are widely used to adsorb odorous or coloured substances from gases or liquids.

When a material adsorbs something it attaches to it by chemical attraction. The huge surface area of activated charcoal gives it countless bonding sites. When certain chemicals pass next to the carbon surface they attach to the surface and are trapped. Activated charcoal is good at trapping other carbon-based impurities (organic chemicals) as well as things like chlorine. Many other chemicals are not attracted to carbon at all, sodium, nitrates etc. So they pass right through. This means an activated charcoal filter will remove certain impurities while ignoring others. It also means that once all of the bonding sites are filled, an activated charcoal filter stops working. At that point you must replace the filter.

Activated charcoal can remove organic materials from gas streams or solutions. The amount of material removed depends on the capacity of the activated carbon (activated charcoal) as well as the affinity of the material for the charcoal [12].

In fact, activated charcoal filters are used today in drinking water treatment to remove the natural organic compounds (i.e. tannins) that produce carcinogenic chlorinated by-products during chlorine disinfection of water.

***Decolourization Process Using an Activated Charcoal***

Decolourization simply means colour removal. The chemical nature of activated charcoal combined with a high surface area and porosity, makes it an ideal medium for the adsorption of organic chemicals.

To improve colour of gum Arabic sample for instance, the initial colour have to be removed with the aid of decolourizing agents. In the laboratory there are many decolourizing agent such as chloro-compounds, activated aluminium silica gels and carbonaceous compounds like activated charcoal. The most widely used of these decolourizing agents is the activated charcoal due to its economic advantages over others, its availability and its chemical inertness towards most of our materials of construction. The chloro-compounds on the other hand are usually corrosive, causes damage and interfere with chemical composition of the product. Where they are available they are often found to be costly.

In this decolourization process therefore, solid activated charcoal shall be employed as our adsorbent. The process by which the colour is removed from the gum Arabic sample is the adsorption process.

Adsorption is a separation process in which certain components of a fluid phase are transferred to the surface of a solid adsorbent.

Most adsorbents are highly porous materials and adsorption takes place primary on the walls of the pores or at specific sites inside the particle. Because the pore are generally very small, the internal surface area is in the order of magnitude greater than the external area and may be as large as $2000m^2/g$. Separation occurs because differences in molecular weight, shape or polarity causes some molecules to be held more strongly on the surface than others or because the pores are too small to admit the larger molecules. In many cases, the adsorbing components (or adsorbate) is held strongly enough to permit complete removal of that component from the fluid with very little adsorption of other components.

In the decolourization of unsorted and sorted gum Arabic solution using activated charcoal therefore, it is expected that when the gum Arabic solutions are introduced into the bed of activated charcoal the pigment and colour matters will be forced to concentrate them on the surface provided by the activated charcoal molecules.

## Experimental Methodology

A plastic measuring cylinder was used as the adsorption column and an activated charcoal of 500μm particle size was charged into the adsorption column after a filter cloth had been placed at the bottom. The column was charged until the height of the bed was 10cm. Another filter cloth was then placed above the activated charcoal to prevent any impurity such as sand, tree barks from entering the activated charcoal. The bed was then washed with distilled water to remove ash and other dirt’s from the activated charcoal. This was done by pouring the distilled water from the top of the column and the water that passed through was collected in a beaker and compared with that in a beaker containing distilled water. This was repeated until the water collected from the column was as clear as that in the other beaker. When this was completed, few minutes were allowed for the water to drain.

After this washing, 20ml of the unsorted gum Arabic solution was then poured in a conical flask labelled A, another 20ml of the sorted gum Arabic solution was poured in another conical flask and then labelled E.

The remaining unsorted gum Arabic solution was then poured into the column. A total of 1000ml of the unsorted Gum Arabic solution was used and this was done in such a way that the column was filled to the top (brim) in order to exert enough pressure to push down the solution through the bed. The solution that passed through the bed was then collected in a beaker and 20ml was then taken into another conical flask and was labelled B, the remaining solution was then poured into the bed again an after passing through the bed this second time the solution was then collected in a beaker and 20ml was again taken into another conical flask and was labelled C, after which the remaining solution was then filtered using a filter paper and the solution was collected in a beaker and 20ml of this solution was then taken into another conical flask and was labelled D.

After this whole procedure, the decolourization process using the unsorted gum Arabic solution was then completed and that of the sorted was then carried out using the same procedure. A total of 1000ml of the sorted gum Arabic solution was also used but this time around the 20ml taken into the conical flask after passing through the bed for the first time was labelled F, the 20ml taken into the conical flask after passing through the bed for the second time was labelled G and finally the last solution collected was filtered using a filter paper and was labelled H.

Finally the eight samples collected (A-H) were arranged alphabetically and the transmittance, pH and the viscosity of the different solutions contained in the conical flasks labelled (A-H) were determined.

The transmittance of gum Arabic solution was determined using a spectrophotometer (colorimeter), the pH was measured using a pH meter and viscosity determined using the viscometer.

Issue 7, July-December 2005
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**Results**

The PH, viscosity and transmittance obtained for both the unsorted and sorted Gum Arabic solutions before and after decolourization labelled (A-H) are shown in the tables below.

*Table 1. Transmittance of unsorted gum Arabic solution before and after decolourization*

| Sample | pH | Viscosity | % Transmittance | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 430λ | 470 λ | 490λ | 520λ | 540λ | 580λ | 600λ | 710λ |
| A | 4.58 | 3.7500 | 1.0 | 2.2 | 3.5 | 4.4 | 5.3 | 7.6 | 8.4 | 9.8 |
| B | 5.20 | 2.5000 | 10.0 | 18.2 | 25.0 | 28.0 | 32.4 | 39.0 | 44.3 | 48.2 |
| C | 5.50 | 2.2500 | 20.0 | 24.5 | 36.1 | 45.0 | 52.4 | 64.6 | 71.2 | 80.0 |
| D | 5.70 | 1.8500 | 25.0 | 32.5 | 45.2 | 63.6 | 70.8 | 76.4 | 81.0 | 85.0 |

*Table 2. Transmittance of sorted gum Arabic solution before and after decolourization*

| Sample | pH | Viscosity | % Transmittance | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 430λ | 470λ | 490λ | 520λ | 540λ | 580λ | 600λ | 710λ |
| E | 4.40 | 3.9800 | 2.0 | 3.2 | 4.1 | 5.3 | 6.4 | 7.5 | 8.6 | 9.9 |
| F | 5.00 | 2.7500 | 12.4 | 18.8 | 26.2 | 32.5 | 37.0 | 41.3 | 54.0 | 59.0 |
| G | 5.30 | 2.5600 | 22.5 | 26.0 | 38.4 | 50.1 | 56.3 | 67.8 | 76.2 | 84.0 |
| G | 5.60 | 1.9500 | 26.0 | 38.2 | 47.5 | 69.4 | 78.2 | 79.5 | 86.0 | 95.5 |

In the experimental results shown above, the alphabet (A - H) represents the following information:

A - Unsorted Gum Arabic solution before decolourization.

B - Gum Arabic solution after been passed through the bed once.

C - Gum Arabic solution after been passed through the bed twice.

D - Gum Arabic solution after been passed through the bed for the 2$^{nd}$ time and filtered.

E - Sorted Gum Arabic solution before decolourization.

F - Gum Arabic solution after been passed through the bed once.

G - Gum Arabic solution after been passed through the bed twice.

H - Gum Arabic solution after been passed through the bed for the 2$^{nd}$ time and filtered.

**Discussions**

In the table of result, it is obvious that as the decolourization process continue, the pH values increases while the viscosity decreases. This shows that the presence of the colour impurities in the solution reduces the pH of the solution while on the other hand it increases the viscosity of the solution. This phenomenon is observed both for the unsorted and sorted values of the pH and viscosity of the gum Arabic solution.

Also, the pH of the sorted gum Arabic solution is slightly lower than that of the unsorted Gum Arabic solution which shows that the presence of tree barks, sand etc present in the initial stage before the decolourization also affected the pH.

Similarly, the viscosity value of the sorted gum Arabic solution is slightly higher than that of the unsorted Gum Arabic solution which also confirms the influence of the tree barks and sand that was found or present in the initial stage of the unsorted solution before the decolourization process.

Moreover, the transmittance values for both the unsorted and sorted solutions (A - H) increases with increase in wavelength. Also, from the table, the transmittance of the unsorted and sorted gum Arabic solution before decolourization A and E respectively falls within the range of 1 - 10 % which shows that the solutions are deeply coloured as such most of the light that passes through the solutions are been absorbed there by allowing the only 1 - 10% of the light to pass through.

Similarly, for solution B and F which are the solutions of unsorted and sorted gum Arabic respectively after been passed through the bed once, has transmittance values ranging between 10 - 60% which shows that some of the colour impurities have been removed thereby allowing more percentage of the light to be transmitted or pass through the solution.

Similarly, for solution C and G which are the unsorted and sorted gum Arabic solutions respectively after been passed through the bed twice, has transmittance values ranging between 20 - 84% which shows that more of the colour impurities are been removed thereby allowing more percentage of the light again to be transmitted or pass through the solution.

Finally, for solution D and H which are unsorted and sorted gum Arabic solutions respectively after been passed through the bed for the second time and filtered, has transmittance values ranging between 25 - 96% which is now obvious that only few colour impurities are present in the solutions, as such the solutions are now faintly coloured with just a very small percentage of the light been absorbed thereby allowing most percentage of the light to be transmitted or passed through the solution.

## Conclusion

Based on the results obtained, it can be concluded that the decolourization of the gum Arabic solution was successfully carried out with the use of activated charcoal.

## Recommendation

Decolourization of gum Arabic should always be carried out before some additives or preservatives are used on the gum to ensure better quality of the gum.

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