



## PURIFICATION OF TIGERS RIVER WATER BY ARABIC GUM AS A NATURAL COAGULANT

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### ABSTRACT

The study aimed to use arabic gum polymer which is a natural coagulant for water purification as an alternative coagulant or coagulant aid of chemical coagulant for much safer to human s health and high efficient of turbidity removal. This study comprised using arabic gum for reducing water turbidity, total organic carbon and total suspended solids of Tigris river water with initial turbidity 53,100 and 200 NTU. Various doses of coagulants 5,10,20,30 and 40 ppm, three temperatures 25C°,35C° and 45C°, six interval sedimentation 20 min, 1, 2, 5, 12 and 25 hour were examined by using jar test. Combination of arabic gum to chemical coagulant (alum) was examined else. Results indicated that the optimum doses of arabic gum was 5 ppm for initial turbidity 53 NTU and 10 ppm for initial turbidity 100 and 200 NTU at optimum pH 9 during 2 hours of sedimentation time, turbidity removal were 72.8%, 77.9% and 76.7% for three levels of turbid water respectively, there is no significant difference between various temperatures in water treatment. Results showed maximum significant difference (P 0.05) of turbidity removal obtained by combination of 0.5 doses for each of alum and arabic gum as a coagulant-flocculation which were 83.4%, 86.7% and 88.2% for three levels of turbid water respectively. Natural coagulant showed many advantages such as slight change of pH and reduce salinity in treated water and didn't cause diseases that those caused by inorganic coagulants (alum) and more protective material for human s health.

**KEY WORDS:** Arabic gum, Tigers River, turbidity, purification, alum, total organic compounds.

### INTRODUCTION

Fresh water is crucial object for human life; it is a very little portion equal or less than 2% of total water on the globe. In recent years clean fresh water become a major concern throughout the world. Large sections of peoples are depending on contaminated water for drinking without any treatment and more than 780 million of people are still without access to improve sources of drinking water<sup>[14]</sup>. Potable water often is produced from surface water and usually involve one or multiple contaminated unwanted substances such as suspended solid, organic compounds and aggregated microorganisms that it is cause for many diseases<sup>[4]</sup>. Particles size in water that is least than 0.01 mm still in suspension as contaminated form to cause many problems, but those are a larger precipitated on bottom and easy separation from water<sup>[1,8,12]</sup>. Alum is a chemical coagulant widely used for water treatment and has high efficient in water purification. Most of studies confirmed that alum could be decomposed into treated water to produce aluminum ion, high concentration of residual aluminum in water is responsible for many diseases such as human's brain damage and Alzheimer disease, as well as it's effect to reduce pH, not efficient in cold water and cause increase salinity in water due to releasing of sulfate ion in water. In most rural regains, water purification by chemical coagulation are impractical because of high cost of equipments and always this materials is not available<sup>[9]</sup>. Therefore more studies focused to find methods that is more safety for human,

eco-friendly and available locally. Plant extracts are used in many applications such as food process as nutrient sources so it is used for pharmaceutical purposes such as medical extracts for treatment of diabetes and obesity cases as well as used as a natural coagulant for water purification, use mainly coagulant or combine to alum for increase efficiency of turbidity removal also reduce required alum dosage for water treatment. Few studies have focused to use various plants in water purification, these studies comprised using one part of particular plant species or its extract for water treatment<sup>[7]</sup>. There are many advantages for using natural coagulant in water treatment such as plant's sludge could be biodegradable and little volume that it is only 20–30% comparison to alum's sludge so it is safety for human s health, some plant extract also suitable as antimicrobial agent to kill and disinfect pathogenic microorganisms<sup>[7]</sup>.

There are many types of natural materials used in water treatment one of them is called arabic gum (*Sengalia Senegal*) also known acacia gum is produced from various species of acacia tree mostly in Sudan .

Arabic gum is a complex mixture of glycoproteins and polysaccharides, this gum used in various purposes such as food processes and water treatment applications<sup>[12]</sup>. Current study aimed to use arabic gum as a natural coagulant with alum to reduce water turbidity, total suspended solid and organic materials for three levels of turbid water 53,100 and 200 NTU, in addition, reduce alum dose that is required for water treatment.

## MATERIALS & METHODS

### 1- Preparation of arabic gum

Preparation of arabic gum solution by dissolving 1 gm of material in 1000 ml of distilled water to prepare concentration of 1000 ppm and mixed for 20 min<sup>[12]</sup>.

### 2- Physicochemical properties of arabic gum solution

Arabic gum solutions were prepared for doses 10 and 20 ppm in distilled water, it is near to concentrations that were used in experimental work, at initial, pH of distilled water was 7.

Physicochemical properties included pH, viscosity, density, surface tension, refractive index, electrical conductivity.

### 3- Preparation of alum solution

Aluminum sulfate solution (alum) was prepared to dissolve 10 g of alum in 1 liter of distilled water to prepare concentration 10,000ppm. kept into tightly glass bottle for using in experimental work<sup>[12]</sup>.

### 4- Sampling of raw water

Water sample of Tigris river was brought from Jadriya region in October / 2016. The sample was preserved into plastic container at a temperature 5 C° and subjected to some analyses<sup>[13]</sup>.

### 5- preparation of turbid water

The synthetic turbid water was prepared by soaking 30g of pure natural clay after milling and sieving in 1 liter of distilled water, mixed for one hour by shaker with speed of 100 rpm for homogenizing and left until 24 hours to complete hydration. This suspension called stock solution. The filtrate was added to the sample to modify different turbidities of water 53, 100 and 200 NTU during experimental work<sup>[10]</sup>.

### 6- Experimental work by jar test

Water samples were used with three levels of turbid water 53, 100 and 200 NTU, use various doses of arabic gum 5, 10, 20, 30 and 40 ppm at pH ranging between 4-10, it was adjusted to the desired value by adding volume of 0.1 M of NaOH or HCL at three temperatures 25C°, 35C° and 45C° and six time settle 20 min, 1, 2, 5, 12 and 24 hours. Samples were subjected using jar test which composed of 6 beakers, coagulant added into 1 liter of the sample into a specified glass beaker, process included rapid mixing at 200 rpm for 1 minute, then slow mixing at 40 rpm for 20 minutes and allowed to settle for 20 minutes<sup>[1]</sup>, the filtrate was withdrawn from the upper layer of laboratory analyzing, included turbidity, TSS, TOC.

### 7- Turbidity removal calculation

Turbidity removal percentage was calculated, as following equations<sup>[1]</sup>:

$$\text{Turbidity removal (\%)} = \frac{\text{initial turbidity} - \text{final turbidity}}{\text{initial turbidity}} \times 100$$

## RESULTS & DISCUSSION

### Physicochemical properties of raw water samples

Table (1) showed a rise value of all determinants according to increase turbidity of water 53, 100 and 200 NTU which was resulted by increase clay materials, included chemical compounds and salt. This result agreed to other study<sup>[6 15]</sup>, that noted the addition of clay materials in water caused increase of organic, inorganic compounds and other determinates in water.

**TABLE 1:** Physicochemical properties of the river water Samples

parameters	Turbid water	Turbid water	Turbid water
	53 (NTU)	100 (NTU)	200 (NTU)
pH	7.4	7.8	8.2
DOC (ppm)	3.7	3.9	4
TOC (ppm)	14.3	19.5	26.1
EC (µs/cm)	899	1033	1064
TDS (ppm)	570	671	691
TSS (ppm)	37	55.7	129.6
Hardness (ppm)	379	384	393
Alkalinity (ppm)	133.8	148	157.9

### Some properties of arabic gum solution

Table (2) presented little changing of pH and electrical conductivity in prepared solutions comparison to distilled water.

**TABLE 2:** some properties of arabic gum at concentration 10, 20

arabic gum (ppm)	pH	EC (µs/m)	Surface tension (Mn/m <sup>2</sup> )	Refract index	density ( ppm)	viscosity (cp)
10	6.9	5	64.25	1.3331	1.0009	1.567
20	6.9	7	55.35	1.3331	1.0009	1.593

Most of studies indicated that natural coagulants didn't cause significant change of pH, electrical conductivity and total dissolve solids in treated water because it is low content of ionic compounds<sup>[2,3]</sup>. Surface tension of solution was decrease according to add dissolved material in distilled water. Result also observed slight change in refractive index and viscosity due to decrease of prepared concentration at 25C°.

### Optimum conditions for using arabic gum as a mainly coagulant in water purification

Using various dosages of arabic gum for water purification showed in (fig 1), optimum dosages were 5,10 and10 ppm achieved maximum difference (P 0.05) of turbidity removal 65.4%, 60.9% and 63.8% for three levels of turbid water 53, 100 and 200 NTU respectively.

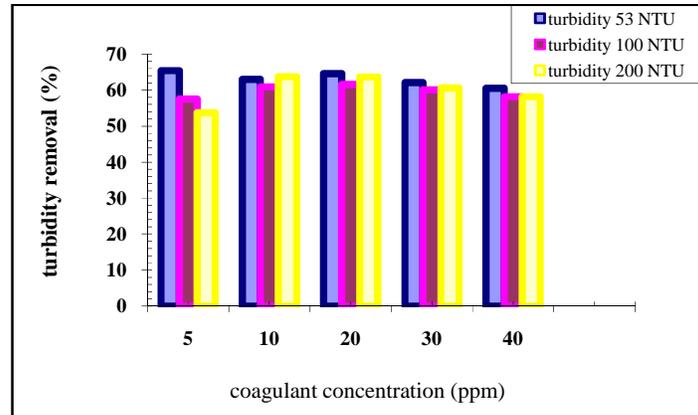


FIGURE 1: effect of various doses of arabic gum on water turbidity removal for three levels of turbid water

Current study correspond to other Study<sup>[12]</sup> which was comprised using concentration of arabic gum between 2-10 ppm with initial turbid water between 100-500 NTU resulted highest turbidity removal.

(Fig 2) showed decrease in total suspended solids from 37, 55.7 and 129.6 to 10.7, 20.1 and 35.8 ppm at optimum dose for three levels of turbid water respectively. Reduction of suspended solids leads to reduce of total organic carbon and microorganism and other compounds in suspension.

There are two mechanisms for turbidity removal, first could be obtained by attachment positive charge of polymer active sides to anion charge of suspended particles to obtain neutralization between opposite charges, this process called adsorption. Second, obtained by bridge formation between one polymer and multiple particles to form floc that contain aggregated suspended solids in little volume and high density then easy settle on bottom.

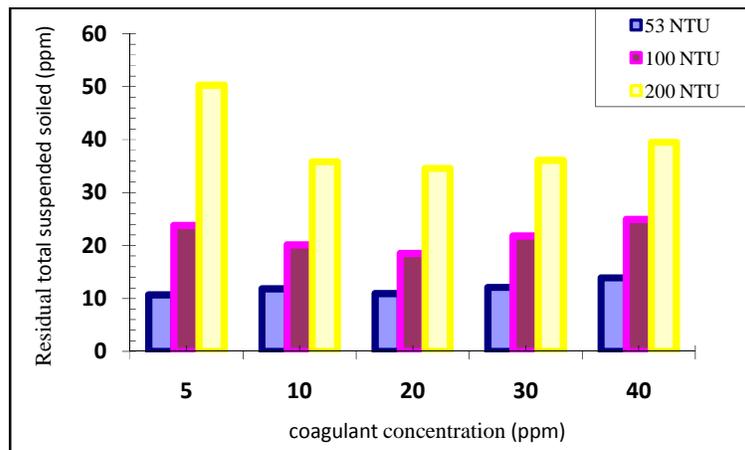


FIGURE 2: residual total suspended solid after treatment when use various doses of arabic gum for three levels of turbid water

Results also indicated there is a slight decrease of electric conductivity of Arabic gum solution, while alum caused slight increase at both doses 10, 20 ppm, due to high concentration of sulfate ion in water which was resulted by alum decomposition, this result indicate that the natural coagulant did not add ionic compounds in treated water as shown in (fig 3).

Influence of pH on turbidity removal shown in (fig 4) at pH 9 gave maximum difference of turbidity removal (P 0.05) at optimum doses which were 69.9%, 71.1%, 73% for three levels of turbid water respectively. pH has an important role for changing electrical charge of effective groups that affect for attachment between coagulant and suspended particles<sup>[9]</sup>.

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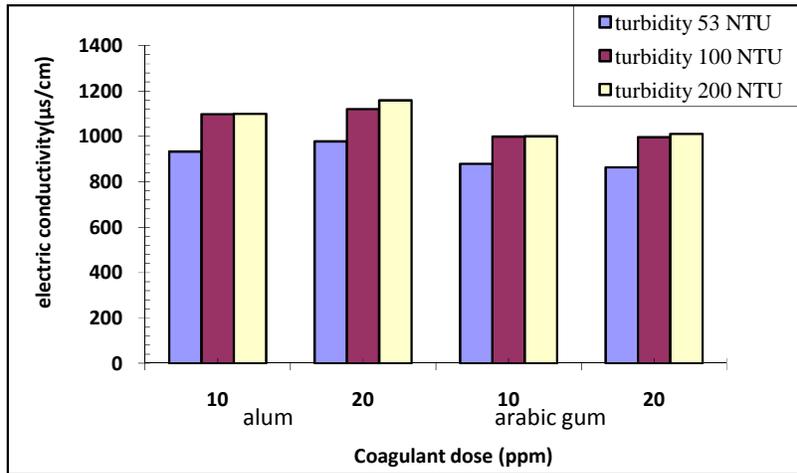


FIGURE 3: effect of alum and arabic gum coagulant at 10 and 20 ppm on electric conductivity of treated water

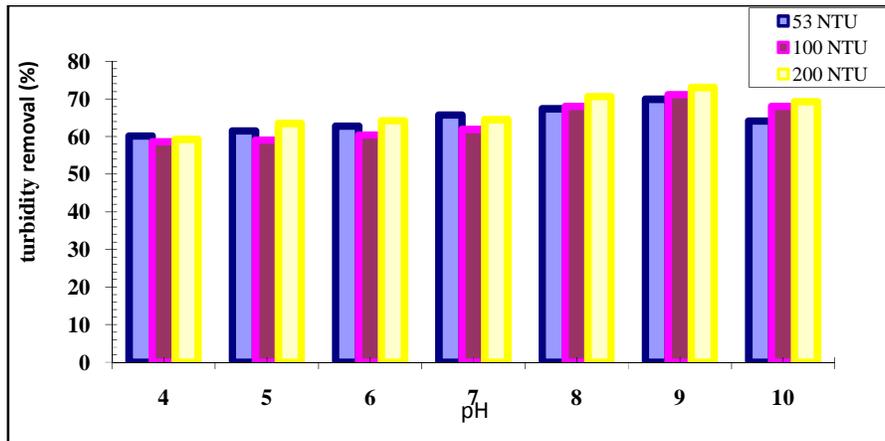


FIGURE 4: effect of pH value on turbidity removal for three levels of turbid water

(Fig 5) presented three Temperatures 25°C, 35°C and 45°C used in study; temperatures had achieved little variation in turbidity removal but were non-significant (P 0.05). Another study indicated of using Conocarpus's leaves extract as a natural coagulant in raw water

purification at a temperature 26 C° had achieved water turbidity removal 48%, while temperature at 55 C° caused significant increase in reduction of water turbidity due to physical changes of polymer according to temperature rise [5].

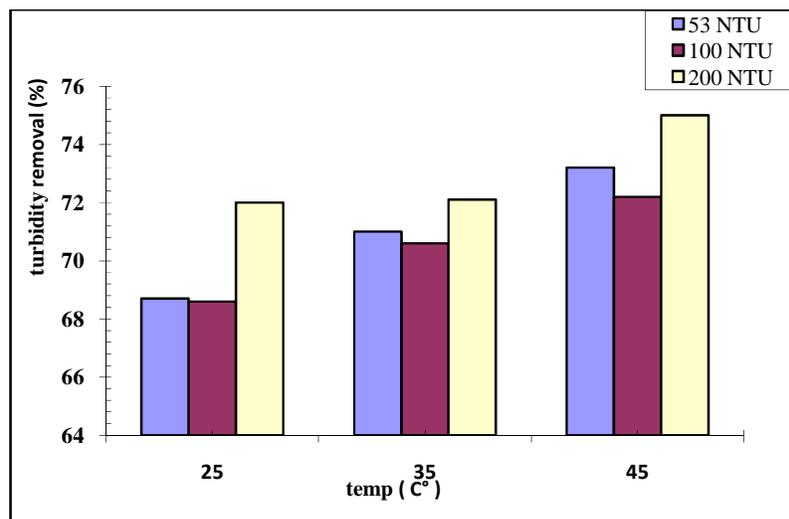


FIGURE 5: effect of three temperatures in turbidity removal for three levels of turbid water

Results of (fig 6) adopted several time of sedimentation in experiments, most of them showed non-significant

differences between 5, 12 and 24 hours, the best period of sedimentation 2 and 5 hour those gave significant

difference of turbidity removal comparison to other treatments were 72.8%, 77.9%, 76.7% and 79%, 81.1%, 78.8% for three levels of turbid water respectively. Other study showed that time of sedimentation should not be

exceeded 4-5 hours for economic purposes, in addition, period more than 5 hours is non-significant for turbidity reduction <sup>[11]</sup>.

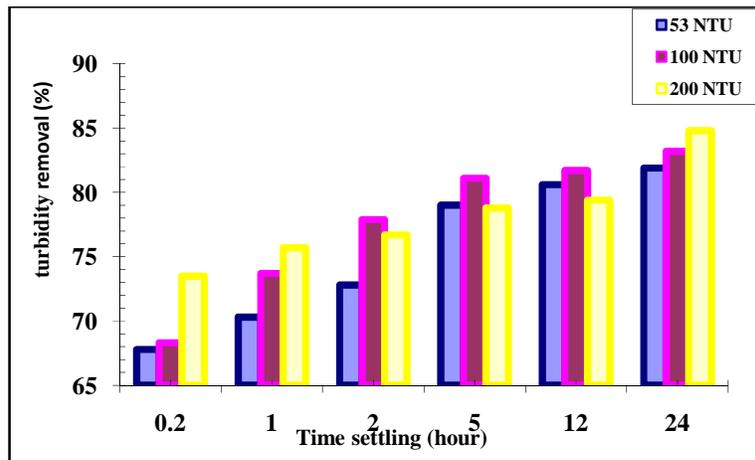


FIGURE 6: several periods of sedimentation were used in experiments for three levels of turbid water

#### Arabic gum as a coagulant aid with alum

(Fig 7) comprised using of 0.5 optimum dose of arabic gum with 0.25 optimum dose of alum, turbidity removal 64.6%, 67.3% and 83.8% for three turbid water levels respectively, while 0.5 optimum dose of each of arabic gum and alum together achieved significant difference of turbidity reduction obtained 83.4%, 86.7% and 88.2% for three turbid water levels respectively. Another Study

indicated using of arabic gum combined to alum in water purification could be reduced alum dose that required for treatment to approximately 15-30% <sup>[12]</sup>.

Current study depended alum doses 10, 20, 35ppm as optimum dose in experimental work for three levels of turbid water 53, 100 and 200 NTU <sup>[12]</sup> achieved turbidity removal were 89.5%, 84.2% and 85% respectively.

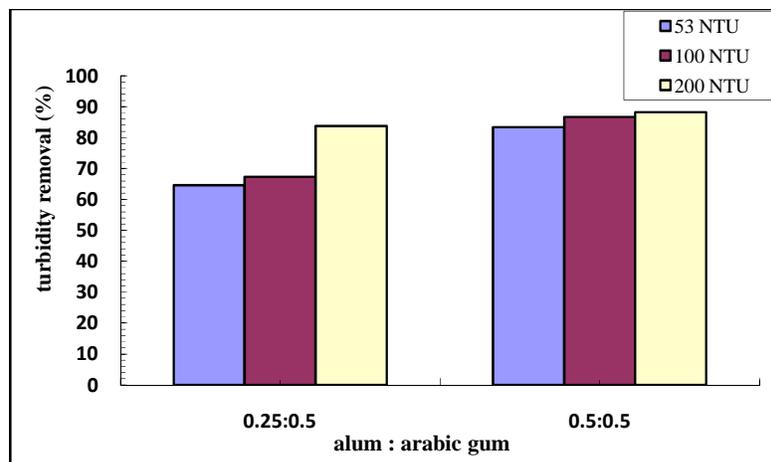


FIGURE 7: Arabic gum coagulant combine to alum with two different ratio for three levels of turbid water

Therefore, using natural coagulants combined to alum was suitable and more efficient at ratio (0.5:0.5) (coagulant aid: alum) comparison to use natural coagulant as a mainly coagulant in drink water treatment as well as the efficiency could be improved by increase dose of coagulant aid or extending time of sedimentation. Thereby harmful effects on human's health could be reduced by decreasing required concentration of alum for water purification between 30-40%.

#### CONCLUSION

Use arabic gum as a mainly eco-friendly coagulant or combined with alum could be reduced high concentration of alum that is required for water treatment and reducing

human's diseases such as brain damage. High reduction in water turbidity is achieved when use arabic gum in alkaline water treatment. In addition, natural coagulant does not changed pH, little sludge volume with biodegradable and easily separated, sludge can be used it for fertilizer and animal feed, as well as could be derived from a renewable resource to use in large-scale of water treatment process, especially in rural regions.

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