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Efficiency Evaluation of Carica Papaya seed, and Aloe Barbadensis in Water Purification

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Abstract: **The coagulation and disinfecting properties of Aloe barbedansis (Aloevera) and Carica papaya seeds from mature fruits were studied in water. A water sample was taken from the local government area of Batagarawa, near the Ajiwa dam in Katsina State, Nigeria. A number of physical, chemical, and biological characteristics were measured for the water sample, including turbidity which showed 256 NTU prior to treatment but decreased to 11 NTU, 36 NTU, and 61 NTU for aluminum sulfate, Aloevera and carica papaya seed treated water respectively. The findings indicated that the Carica papaya seed, Aloevera, and Aluminum Sulfate had effects on pH, for Alluminium sulphate, the pH of the water sample decreased from 7.8 to 6.4. For carica papaya, the pH decreased from 7.8 to 7.4, and for aloevera, it showed a rise in pH from 7.8 to 8.1. The raw water's BOD level is 6.5 mg/l; however, after treatment, it has reduced to 1.5 mg/l, 3 mg/l, and 2.9 mg/l for aluminum Sulfate, aloevera and carica papaya seed, respectively. Before treatment, the raw water's total caliform count was 16 MPN/ml. Following treatment, this count decreased to 1 MPN/ml, 10 ppm/ml, and 8 MPN/ml for water sample treated with chlorine, carica papaya, and aloevera, respectively. Raw water for Styphyloccus aureus has 1657 CFU/ml, following treatment, the levels of chlorine, carica papaya, and aloevera decreased to 2 cfu/ml, 11 cfu/ml, and 9 cfu/ml, respectively. Before treatment, the amount of fecal streptococcus was 1035 CFU/ml; this was lowered to 1 CFU/ml, 10 CFU/ml, and 8 CFU/ml for water sample treated with chlorine, carica papaya, and aloevera, respectively. The laboratory tests were conducted utilizing accepted analytical techniques and protocols for the evaluation of water quality. The outcome demonstrates the utility of Carica papaya seed and Aloevera for disinfecting home water was satisfactory.**

Keywords: **water treatment, water quality, disinfection, aloevera, carica papaya, Aluminum Sulfate, chlorine.**

I. INTRODUCTION

According to [1], water is one of the most prevalent chemicals on Earth and is necessary for life to exist. It is found in the earth's atmosphere as vapor and makes up more than seventy percent (70%) of the planet's surface. Because of its capacity to dissolve practically all organic and inorganic solids, gasses, and other materials that come into contact with it, it is referred to as the universal solvent [2]. Pure water is therefore not found in nature, even the purest natural water, rainwater, has contaminants dissolved from the surrounding air. Only specific distillation techniques and chemical reactions in labs can produce pure water [3]. According to [4], pure water is a colorless, odorless, and tasteless liquid. The densest point for liquid water is 4° C (39.2° F). The density of various liquids and solids is expressed in terms of the density of water at this particular temperature. One kilogram of water has a density of one gram per cubic centimeter at 4° C. Water rises in the atmosphere as a vapor because it is lighter than air in its gaseous state [5]. The act of eliminating unwanted substances, materials, and biological impurities from raw water is called water treatment, sometimes referred to as water purification [6]. Ensuring that the quality of the water delivered to consumers is within acceptable criteria is the aim of water treatment [7]. The contaminants that are anticipated to pollute the water will determine the best treatment strategy for a given water source [8]. Water treatment may not be necessary in upland, unpopulated places where rivers and lakes are abundant with clean water. It is possible, nevertheless, that germs and bacteria are present. According to [9], coagulation and disinfection facilities are therefore required to handle this kind of contamination. Since the pH of many upland sources is low, modifications might be necessary. Conversely, low land surface water sources typically contain

high levels of suspended particles, dissolved components, algae, and bacteria, all of which can necessitate elaborate and costly treatment procedures [10]

Many countries have used natural plant extracts for water filtration since ancient times. According to [11], the majority of them come from the fruits, roots, bark or sap, seeds, and leaves of plants and trees. Thus, using natural resources in the water treatment process is a potentially promising option to both provide drinking water to as many people as possible and decrease the high costs and environmental problems associated with using synthetic chemicals [12]. For efficient turbidity removal in the traditional coagulation and flocculation process, coagulants such as alum, ferric chloride, and ferrous sulphate were utilized. However, a study indicates that long-term alum consumption has resulted in a number of health-related issues [13]. Therefore, in this research natural fruits namely: Aloe barbadensis plant otherwise known as aloevera and carica papaya seed were used for the treatment of water in terms of purity and disinfection and compared to conventional chemicals used in water treatment.

II. MATERIALS

A. Materials

i. **Aloe barbadensis (Aloevera juice**)

The Aloe barbadensisplant is referred to as aloe vera. The most widely used medical plant in the world and the oldest known medicinal plant. This tropical perennial plant can be grown in regions that are prone to drought.

ii. Carica papaya seed

Native to Central America, the carica papaya is a tropical fruit-bearing plant. It is well-known for its mouthwateringly sweet fruit, which has tiny black seeds with a hint of bitterness. They are present within the papaya plant's fruit.

iii. Aluminium sulfate (Al_2 $(SO_4)_3$)

Al_2 $(SO_4)_3$ is the formula for the chemical compound aluminum sulfate. It is soluble in water and mostly employed in waste water treatment facilities and drinking water purification as a coagulating agent, which encourages particle collision by neutralizing charge.

iv. Chlorine (Cl)

This is a chemical used in water treatment, chlorine is used in water treatment for disinfection against unwanted biological organisms in the water.

III. METHODS

i. Sample collection and preparation

a. Preparation of Aloe Vera gel

To get rid of the dirt, the leaves were rinsed under the faucet. The gel portion was carefully separated from the thick green coat, or epidermis. The gel portion was then blended into a liquid using a blender and kept in glass bottles in the refrigerator. A 2% dilution of aloe vera was created by diluting 2 milliliters of aloe vera gel with 100 milliliters of distilled water, which is a similar variation in aloe vera percentage.

b. Preparation of carica papaya seed

The seeds of carica papaya fruits were taken out and put in a bowl after they were sliced open. Using a mortar and pestle, the seed coat was broken off, and the clean seeds were obtained by vigorously washing away any remaining material. After being cleaned, the seeds were spread out on foil and dried for 48 hours at 40°C in the oven. In preparation for extraction, the dried seeds were ground into a powder using a grinder and carefully preserved in sealed, sterile polythene containers.

c. Preparation of stock solutions

To get rid of the big particles, the powdered Carica papaya seed was sieved. To create a 100 ml solution, 2 g of the powder was mixed with 100 ml of distilled water. After extracting the active ingredient from the suspension for five minutes using a clean magnetic stirrer, the mixture was filtered through filter paper to get rid of any remaining solids. The resulting stock solutions were kept at 3°C in a refrigerator.

ii. Experiments for Coagulation/ Flocculation

The jar test was employed, with 5ml,10ml,15ml,20ml,25ml and 30ml and papaya, aloevera, and alum solution mixed in six jars each filled with 500 milliliters of distilled water. The solutions were mixed quickly for two minutes, then gently for ten minutes using the jar test apparatus (flucculator) to aid in coagulant formation. The suspensions were allowed to stand undisturbed for one hour, after which the turbidity of each jar was measured with a turbidity meter to ascertain the percentage removal for each coagulant utilized.

iii. **Microbial analysis and physicochemical analysis**.

To ascertain the water sample's microbiological purity, a microbial examination was carried out. The most likely number (MPN) of total coliform bacteria was estimated, along with the counts of fecal streptococcal and staphylococcus bacteria, and these tests were carried out both before and after the water sample was treated with a mixture of Aluminium sulphate, aloe vera gel,carica papaya seed solution and chlorine..

iv. Staphylococcus test

Using the pour plate method, the culture was carried out on nutrient agar medium and incubated for 24 hours at 37°C. The colonies that were seen were pigmented and butyrous opaque. Colonies were tallied and documented.

v. Streptococcus test

Using the pour plate method, Streptococcus sppwere isolated and counted on blood agar medium. 24 hours of incubation were spent at 37°C. A region of hemolysis encircled the translucent colonies. A count and record of the colonies were made.

vi. Total coliform using most probable number (MPN) method

The bottle was repeatedly inverted to completely mix the water sample. After removing the cap, 50 ml of water was added to the bottle holding 50 ml of double-strength MarConkey soup. Additionally, 10 ml of water were added to each of the five bottles holding 10 ml of double-strength MarConkey broth using a 10-milliliter syringe Additionally, 1 milliliter of water was added to each of the five bottles, which each held 5 milliliters of single-strength MacConkey broth. 10 ml of water was added to each of the five bottles holding 10 ml of MarConkey soup (double strength) and 50 ml of water was added to the container holding 50 ml of the double-strength broth. The bottles were loosely sealed and the inoculation broths were then incubated for 24 hours at 44°C. Following the incubation time, the outcome was logged and interpreted.

IV. RESULTS AND DISCUSSIONS

a. Physical characteristics

Physical tests were conducted on water samples collected from the study area. The result is presented in Table I.

TABLE I: RESULT OF PHYSICAL CHARACTERISTICS OF WATER SAMPLE BEFORE TREATMENT

S/No	Water parameter	Unit	Value	WHO Standard	Nigerian standard
1	Temperature	℃	23	Objectionable	objectionable
2	Turbidity	NTU	156	5	-
3	PH	-	7.8	6.5-8.5	-
4	Color	-	-	Objectionable	objectionable
5	Taste	-	-	Objectionable	objectionable
6	Odor	-	-	Objectionable	objectionable
7	BOD	Mg/l	6.5	-	-
8	Total coliform	Mpn/ml	16	-	-
9	Staphylococcus auras	CFU/ml	1657	-	-
10	Fecal streptococcus	CFU/ml	1035	-	-

In this investigation, a turbidity test was performed on a water sample taken from the Ajiwa dam. The cloudiness or haziness of water due to suspended particles is measured as turbidity. Water sampled from Ajiwa dam was subjected to a turbidity test for this investigation.

Table I displays the turbidity test result of the raw water collected prior to treatment, which is 156 NTU. Table I show that the particles that wash up on the surface have a significant impact on the water. After the treatment, the turbidity

decreased from 156 NTU to 11 NTU with a dose of 15 ml/lt of Aluminium sulphate, 36 NTU with a dose of 15 ml/lt of Aloevera gel, and 61 NTU with a dose of 25 ml/l of carica papaya seed as indicated in Table II. This indicates that aluminum sulphate has the highest percentage of turbidity removal at roughly 92%, followed by Aloevera gel at 76% and Carica papaya seed at 60%.

TABLE II: RESULT OF PHYSIOCHEMICAL CHARACTERISTICS OF WATER SAMPLE AFTER TREATMENT WITH ALUMINIUM SULPHATE ALOEVERA AND CARICA PAPAYA

S/No	Water parameter	Unit	Aluminum sulphate	CaricaPapaya	Aloe vera
1	Temperature	0_C	23	23	23
2	Turbidity	NTU	11	61	36
3	pH	-	6.4	7.4	8.1

The results in Table II demonstrate that after coagulation with Alluminium, Aloevera, and Carica papaya seed extracts, the temperature of the water sample has not substantially changed. Prior to coagulation, the water sample's mean temperature was 23°C; this temperature did not change when the combined extract of the two coagulants was added. There is no discernible difference in the temperature of the water sample when Alluminium, Aloevera, and Carica papaya seed extractswere used. A pH test was performed on a sample of water that was taken from the research area. Water's acidity or alkalinity is determined by its pH. Given that it can affect a number of chemical and biological processes, it is a crucial criterion in the evaluation of water quality.

After the water sample was coagulated with a mixture of Aloevera, Carica papaya seed, and Alluminium solutions, its pH was often only minimally altered. The pH of the water sample dropped from 7.8 to 6.4 for alluminium sulphate, from 7.8 to 7.4 for carica papaya, and it indicated that the pH of the Aloe vera had increased from 7.8 to 8.1upon the addition of different concentration dosages of mixed alluminium, aloevera, and Carica papaya seed extract. The extract's hydrogen ions, which counterbalanced the hydroxide ion in the water sample, may be the cause of the smallpH drop that occurred after the water sample was treated with a mixed extract of aluminum sulphate and Carica papaya seed.

b. Biological Characteristic

A biological oxygen demand (BOD) test was run on the water sample that was gathered for this investigation. One important metric for determining how much dissolved oxygen is used by microorganisms during the biological breakdown of organic materials in water is biochemical oxygen demand. BOD is a crucial water quality indicator, especially when determining the extent of organic pollution.

TABLE III: BIOLOGICAL CHARACTERISTIC BEFORE TREATMENT

s/no	Water parameter	unit	values
1	BOD	Mg/l	6.5
2	Total caliform	Mpn/ml	16
3	Styphyloccusaures	CFU/ml	1657
4	Fecal streptococcus	CFU/ml	1035

Table III displays the results of the BOD test for raw water, which was 6.5 mg/l. Following treatment, the BOD value decreased to 1.5 mg/l as indicated in Table IV. Adding chlorine caused the BOD to decrease from 6.5 mg/l to 3 mg/l and for both carica papaya seed and aloevera gel extract, from 6.5 to 2.9 mg/l, respectively. Carica papaya seed extract has a greater BOD as a result.High BOD levels indicate a significant presence of biodegradable organic pollutants, potentially leading to oxygen depletion and negatively impacting aquatic ecosystems affects human lives. Low to moderate BOD levels were found in other water samples that were treated with chlorine and aloevera.Aloevera-treated water has a moderate BOD level as indicated in Table IV, indicating mild contamination. Low BOD levels in a chlorine-treated water sample imply that there isn't much biodegradable organic matter in the water, which is a sign of high-water quality.

TABLE IV: BIOLOGICAL CHARACTERISTIC AFTER TREATMENT

s/no	Water parameter	Unit	Chlorine	C.Papaya	Aloevera
1	BOD	Mg/l	1.5	3	2.9
2	Total coliform	Mpn/ml	1	10	8
3	Staphylococcus aures	CFU/ml	2	11	9
4	Fecal streptococcus	CFU/ml	1	10	8

Table IV displays the average total bacterial count of the water following treatment with Carica papaya seed extract, chlorine and aloevera gel.According to the findings, treating a water sample with chlorine, aloevera gel, and carica papaya solution demonstrated antimicrobial efficacy against total coliform of 15–93.75%, 8–50%, and 6-37.5%, respectively, and against staphylococcus aureus of 99.8%, 99.4%, and 99.3%, and fecal streptococcus of 99.9%, 99.2%, and 99%. According to the results, papaya seed extract from carica has a poor antibacterial efficiency and aloevera has a moderate antimicrobial efficiency. Chlorine, on the other hand, has a high antimicrobial efficiency.

V. CONCLUSION

The purpose of this study is to evaluate the effectiveness of aloe barbadensis and caricapapaya seed in purifying water for human consumption to that of chlorine and aluminum sulfate as chemical disinfectants and coagulants. The goal was accomplished by the laboratory experiments carried out on water samples. The investigation has successfully demonstrated the antibacterial qualities of Alloevera gel and Carica papaya seed solution against total coliform, streptococcus spp., and staphylococcus aureus bacteria, as well as their ability to coagulate water to eliminate turbidity. These extracts have the ability to minimize suspended particles in raw water and act as natural coagulants and antimicrobials, perhaps reducing germs that cause diseases related to water. Aloevera and Carica papaya seed are useful for treating household water.

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