Investigation of the Effectiveness and Efficiency of Mixed Absorbent for the Treatment of Sewage and Surface Water

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Abstract

An agricultural by-product waste: Orange peels mixed with Sodium hydroxide (NaOH) called "Mixed Absorbent" (MA) were used for the treatment of surface water (Stream Water) and Wastewater (Sewage). The research investigates the effectiveness and efficiency of orange peels for the treatment of wastewater and surface water. The experiment was conducted to test f for seven parameters pH, Total Suspended Solid (TSS), Biochemical Oxygen Demand (BOD), E-coli MPN, Coliform MPN, Temperature, and Nitrate. The experimental test was done at Stratech environment laboratory located at 35 Zik's Avenue, Uwani Enugu State, Nigeria. The results after been interpreted and analyzed using the Standard Method for water and wastewater analysis showed in 96hours tested (SW/WW), the pH was 9.2/6.2, Total Suspended Solid (TSS)165mg/l/660mg/l, Biochemical Oxygen Demand (BOD) 35mg/l/380mg/l), E-coli MPN $<3\times10^3/<3\times10^3$MPN, Coliform MPN $<3\times10^3/$ $<39\times10^3$, Temperature 26.5°C/28.5°C, and Nitrate 9.11mg/l/49mg/l. Comparing the results, the surface water has low pollutants and the grams of absorbent used are efficacy in its treatment considering the quality per liter of both water. Higher pollutants that are found in the sewage exhibit little inhibition to the treatment. Thus, more grams of absorbent will be needed to improve its efficacy. "The Absorbent" (MA) used for the treatment reduces the microbes found in both water. This research recommends that the use of orange peels mixed with NaOH as absorbent should be commercialized for the treatment of stream and sewerage water to reduce environmental pollution. Promoting this low-cost and affordable treatment would reduce the volume of solid waste and minimize blockages of drainages and waterways in our urban centers. It would also create a source of income for some of the actors along with fruits and vegetable value chains

Keywords: Absorbent, Treatment, Utilization, Wastewater .

1. Introduction

THE idea of using various agricultural products and by-products for the removal of heavy metals and impurities from the solution has been investigated by several authors. Friedman and Waiss, (1972), Randall et al. (1974), and Henderson et al. (1977) have investigated the efficiency of many different organic waste materials as sorbents for heavy metals. The obvious advantage of this method compared to others is the lower cost involved when organic waste materials are used. Activated carbon adsorption appears to be a particularly competitive and effective process for the removal of heavy metals at trace quantities Huang and Blankenship (1984). However, the use of activated carbon is not suitable for developing countries because of its high cost Panday et al. (1985). For that reason, the uses of low-cost materials as possible media for metal removal from wastewater and river water have been highlighted. Sewage, or wastewater, includes all the water from a household that is used for washing and toilet wastes. Raw wastewater may contain pollutants such as oxygen-depleting substances, suspended solids, nutrients, toxic chemicals, and pathogens that must be treated before it is released to the environment, Mihelcic and Zimmerman, (2010). Over the years, wastewater treatment technologies have been designed and operated at full scale while some more recent ones are on an experimental scale. Waste treatment involves treating what cannot be reclaimed before its eventual disposal to air, water, and land Agunwamba (2001). According to Hammer and Hammer, (2000), water is essential to life, and therefore its adequate conservation and prediction practice should be highly carried out. That means that careful conservation of water quality is very necessary since human beings, plants and animals depend largely on the water for their life. Water quality requirement defers from various industrial and domestic use. Okah (1999) stated that water quality technology is employed to bring raw surface or groundwater to the desired quality for domestic or industrial use. The water quality modeling attempt to simulate changes in the concentration of pollutants, as they move through the environment James, (1993). Over the year, components or state variables have been gradually incorporated into models following the evolution of water quality problems.

Agunwamba (2001) opined that the knowledge of a stream self-purification capacity when waste is discharged into it is extremely important. According to him, this will go a long way to restrict the extent of waste discharged into the river.

The study makes use of orange peel in the treatment of sewage and stream water as an alternative to other available methods. The data used is limited to those obtained from a laboratory experiment. Citrus is widely grown in Nigeria and many other tropical and subtropical regions Piccinelli et al, (2008). As water has neutral pH of 7, showing it is neither acidic nor alkaline; oranges have a pH of between 3.3 and 4.2. oranges contain citric acid, malic acid, and ascorbic acid known as vitamin C.

The constituents of orange peel oil include terpenes such as carveol, carvone, menthol, peril alcohol, and peril aldehyde. Citrus, in addition to providing an ample supply of vitamin C, folic acid, potassium, and pectin, contains a host of active phytochemicals and phytotoxicity substances Al-Saadi (2009). Orange peel contains soluble sugars and pectin as the main components. Rivas et al. recorded that orange peel contains Pectin and hemicelluloses that are rich in galacturonic acid, arabinose, and galactose, but they also contain small amounts of xylose, glucose, and perhaps rhamnose. It has a multiplicity of vitamins, minerals, and antioxidants such as flavonoids, anthocyanins, phenolic acids, and carotenoids in inclusive of nutrients such as fiber that positive effect on health immunity - such as the stomach and digestive system. All these act as anti-infection, anti-cancer, and anti-anti-bacterial properties Kumari R and Kumari N (2020). Orange peels extract has been utilized as an active ingredient in most traditional medicines Erukainure et al (2016). It is also used in biscuit manufacturing industries to produce fiber biscuits Varsha Rani et al (2020). Nevertheless, it is used for skin beauty care as a natural cleanser, astringent, scrub, moisturizer, and toner. It contains antioxidants that slow down wrinkles, sagging, and skin aging. In terms of volume in production, citrus ranks after banana as the world's second fruit crop with more than 108 million tons FAO Statistics (2006). Sweet orange (Citrus sinensis L. Osbeck) commonly called orange is a member of this family and a major source of vitamins, especially vitamin C, sufficient amount of folacin, calcium, potassium, thiamine, niacin, and magnesium Xu, et al (2013). Gorinsterin et al (2001) concluded that orange peels have an abundant source of natural flavonoids, and phenolic compare to the edible portion.

1. METHODOLOGY

2.1 SAMPLE COLLECTION

2.1.1 Stream Water

The stream water (surface water) sample used in this study was collected from the NRCRI Stream located in Umudike using the dipper technique of ASTM (1996) in standard D 5358. The collected water sample was duly labeled and did not exceed 48 hours before use to avoid any significant change in quality between the time of sampling and the time of analysis.

2.1.2 Wastewater (sewage)

The wastewater (sewage) sample used in this study was collected from the central collective system using a manual technique as approved by the EPA (2004) and did not exceed 48 hours before use to avoid any significant change in quality between the time of sampling and the time of analysis.

2.1.3 Orange Peel

The orange peels sample used in this study was collected from retail orange dealers at the Michael Okpara University of Agriculture, located at Umudike, Abia State of Nigeria. The oranges were peeled with a knife and 10 bags of them were collected using the Baco-bag measurement, then sun-dried.

2.2 ABSORBENT PROCESSES

The orange peels were ground into a semi-fine particles size distribution by the use of a Diesel Engine Grinder. It was sieved using a 2.36 mm sieve size or 230 microns. The sieved orange peels were mixed with 0.1mol of NaOH and air-dried for two days before it is ready for use. The experimental test was done at Stratech Environmental Laboratory and Research Centre located at 35 Zik's Avenue, Uwani Enugu State, Nigeria.

2.3 LABORATORY SET UP

Five plastic buckets were filled with domestic wastewater (sewage) to a capacity of two liters (2.0L) each. The buckets were arranged in order of A, B, C, D and E, where sample A was a control. The mixed natural absorbent was added in the samples at the quantity of 0g, 8g, 12g, 16g, and 20g from A-E respectively. The concentrations of pH, BOD (Biochemical Oxygen Demanded), TSS (Total Suspended Solids), E-coli MPN, Coliform MPN, Temperature, and **Nitrate** were measured for 0.5 hours, 1 hour, 2 hours, 4 hours, 24 hours (1 day), 48 hours (2 day), and 96 hours (4 day) using standard methods.

Therefore, Sample A: Contained 0g of sodium hydroxide with orange peel (i.e. control).
Sample B: Contained 8g of sodium hydroxide with orange peel
Sample C: Contained 12g of sodium hydroxide with orange peel
Sample D: Contained 16g of sodium hydroxide with orange peel
Sample E: Contained 20g of sodium hydroxide with orange peel

The pH was determined by an electrometric method using glass and a reference electrode. The Coliform standard test was carried out using a multiple tube fermentation technique with maconkey broth. The dilution method was used for the determination of the biochemical oxygen demand as approved by the American Public Health Association (APHA, 1992), and standard method 2540 D was used for measuring the suspended solids. E-Coli MPN determination was done with further inoculation on the Coliform MPN result for the positive tubes using EMB agar. And incubate for 24hours at the temperature of 35°C in the air. A thermometer was used for the measurement of temperature.

3 RESULTS AND DISCUSSION

The results of investigation of the effectiveness and efficiency of orange peels for the treatment of wastewater and surface water are illustrated in Figures 1 – 13.

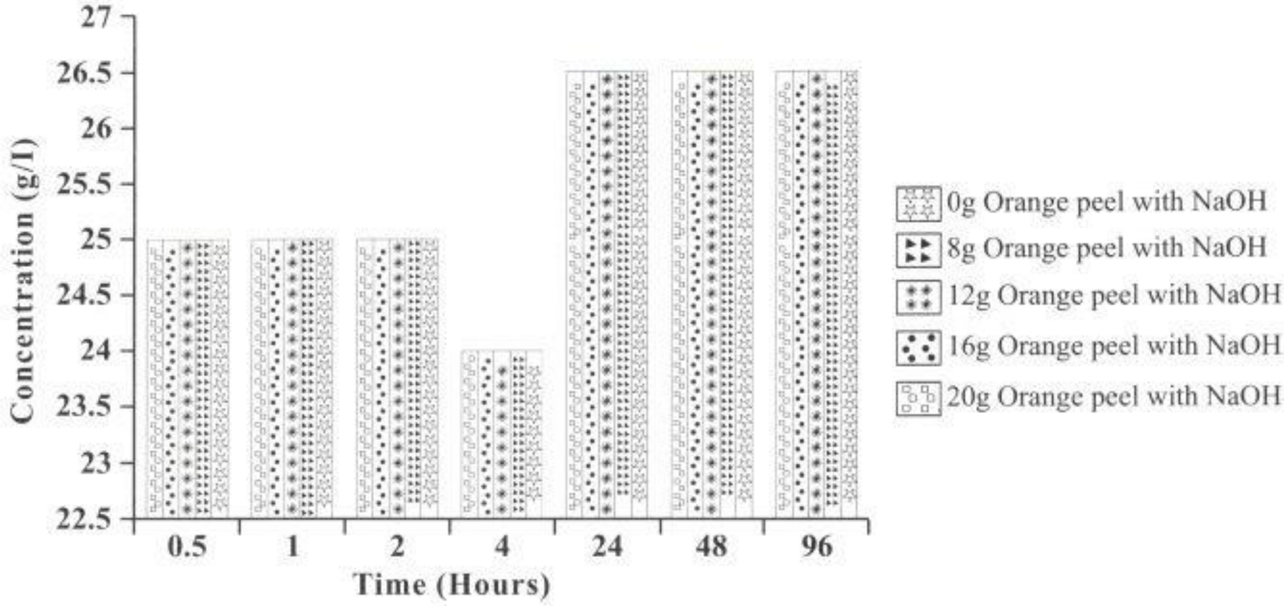

Figure 1: temperature °C test values for River water

At 0.5 to 2 hours the surface water and the wastewater (sewage) have a constant temperature. The surface water has a constant value of 28°C while that of the wastewater (sewage) is 25°C. Results show that as time increases there is a change in temperature on both water tested (see Figures. 1 and 2).

Both samples have decreased in Nitrate as time increases and it shows that Nitrate can be treated with respect to time, on the addition of mixed absorbent as shown in Figures 3 and 4. At 96 hours the level of nitrate in stream water and sewage (SW/WW) are 9.11mg/l and 49mg/l respectively. These show that the level of pollution of the water (SW/WW) was minimized.

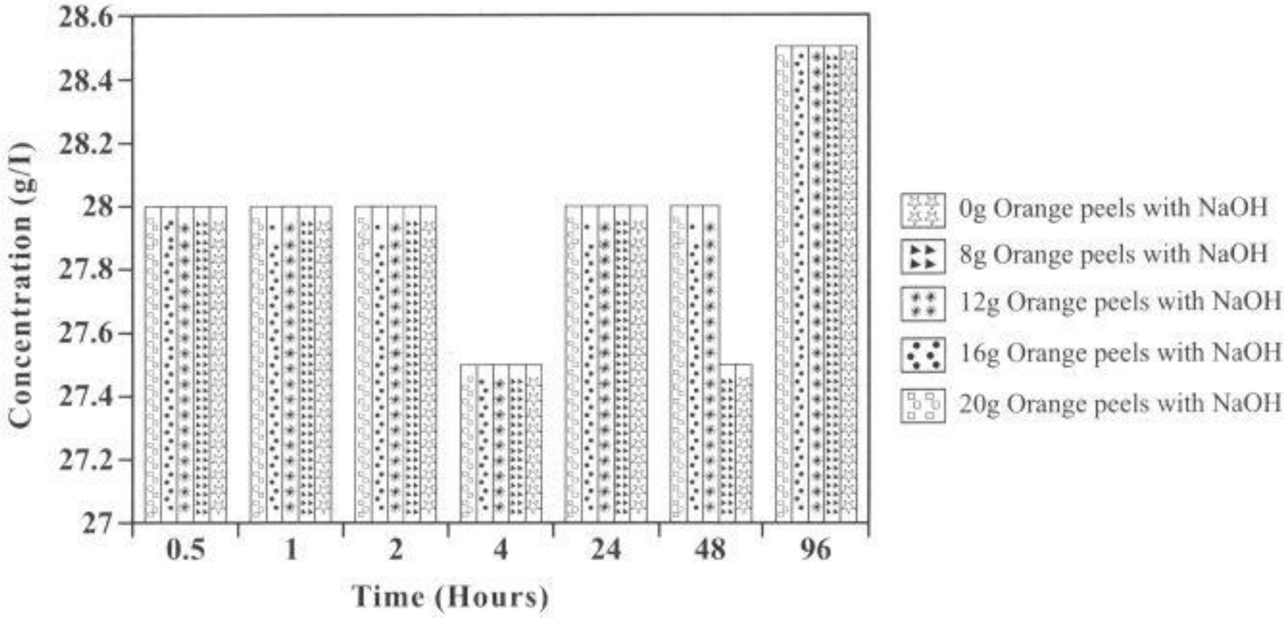

Figure 2: Temperature °C test value for Sewage water

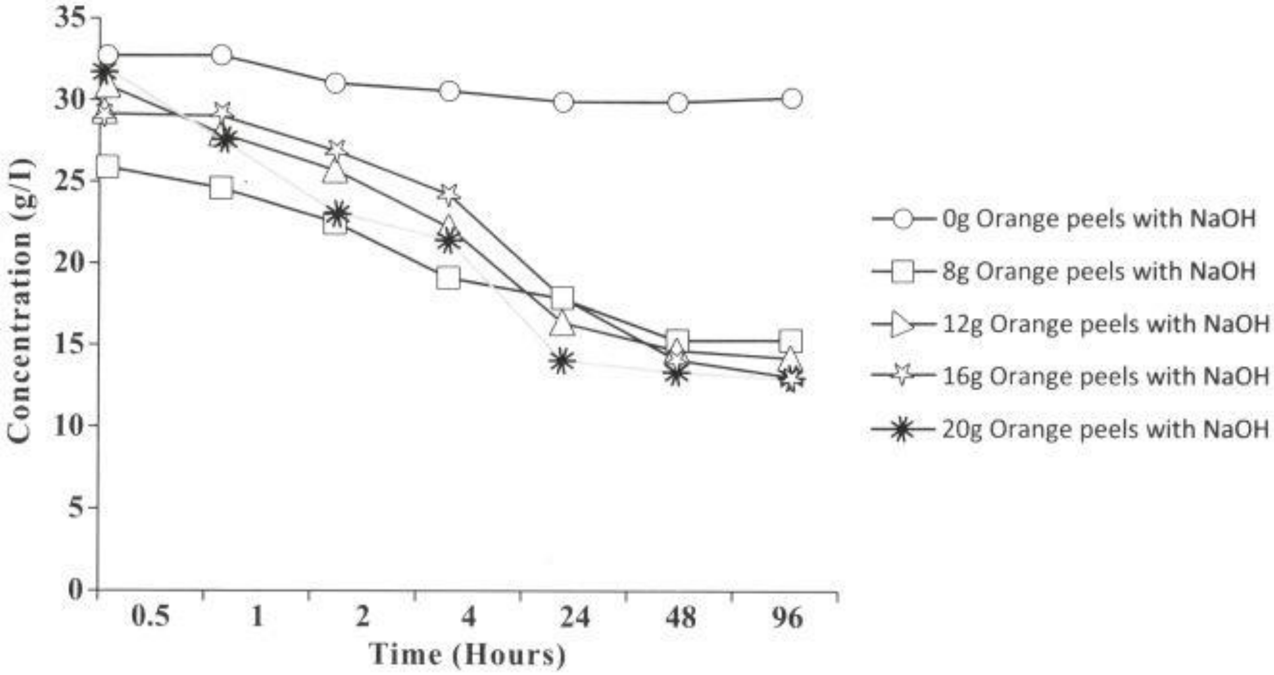

Figure 3: Nitrate concentration in River water

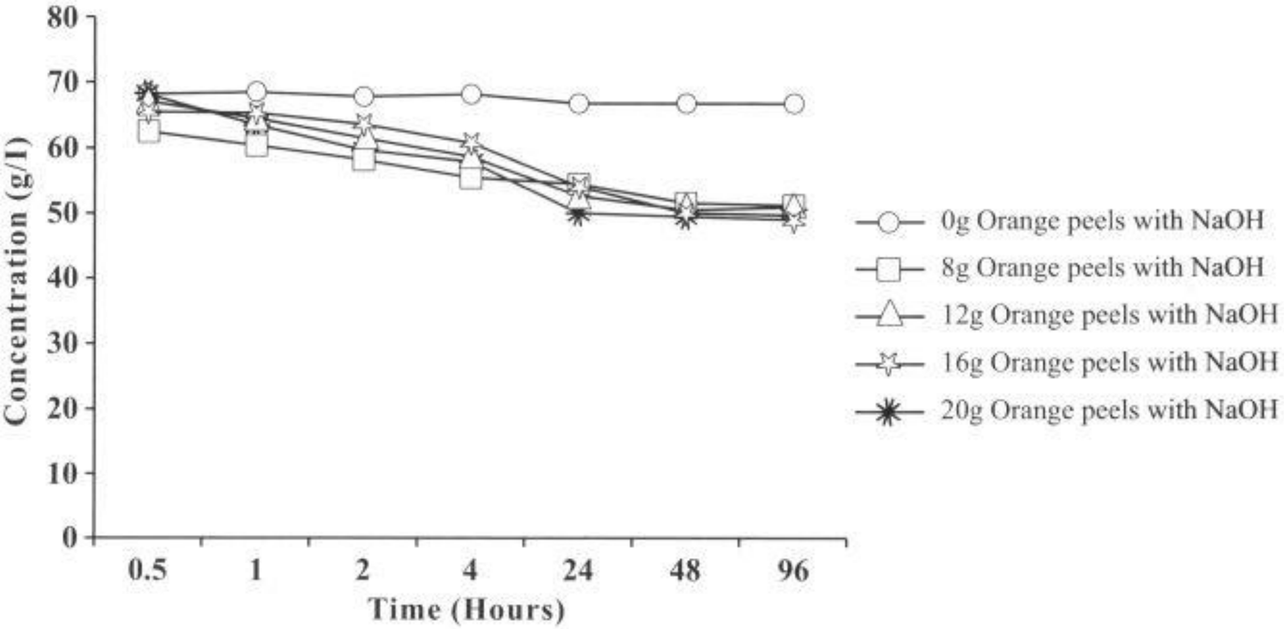

Figure 4: Nitrate concentrations in sewage

The pH of the Surface-water varies with time. It rises from 0.5 hours and falls at 4 hours of sand increased rapidly at 24 hours. In the sewage sampled water, at 0.5 hours it Increases and is seen to decrease with time, on the addition of mixed absorbent, as shown in Figures 5 and 6. This implies that acidity in wastewater decreases long side with time, while the surface water increases. Thus, still at the range level of international limit for domestic purposes.

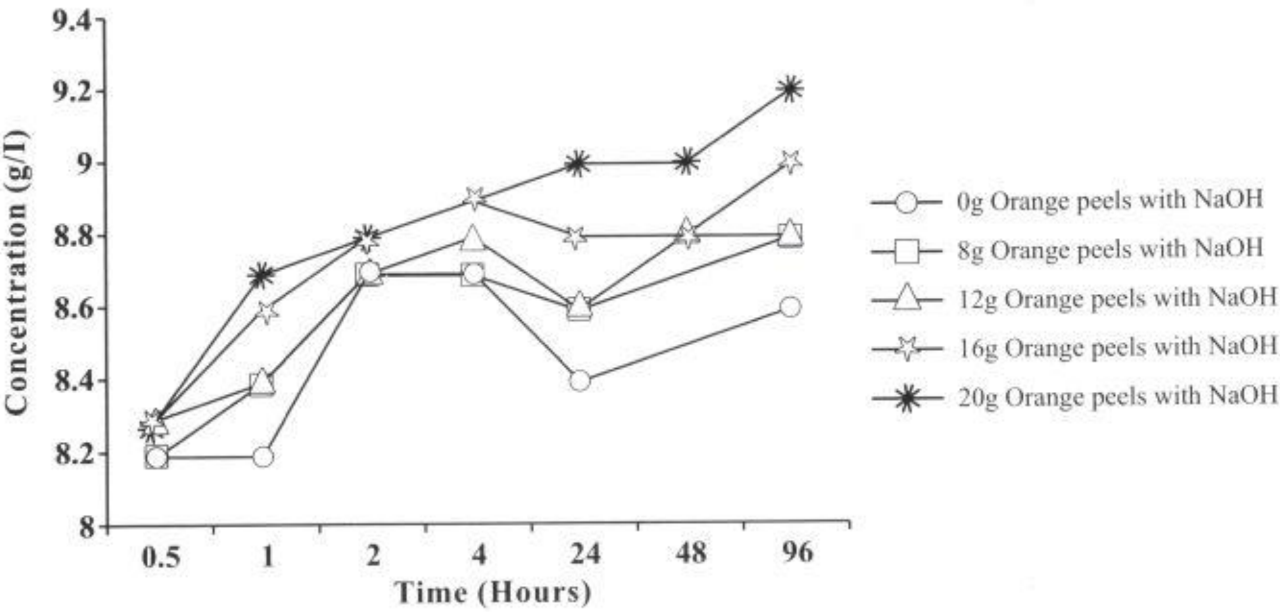

Figure 5: ***Variation of pH over time for River Water***

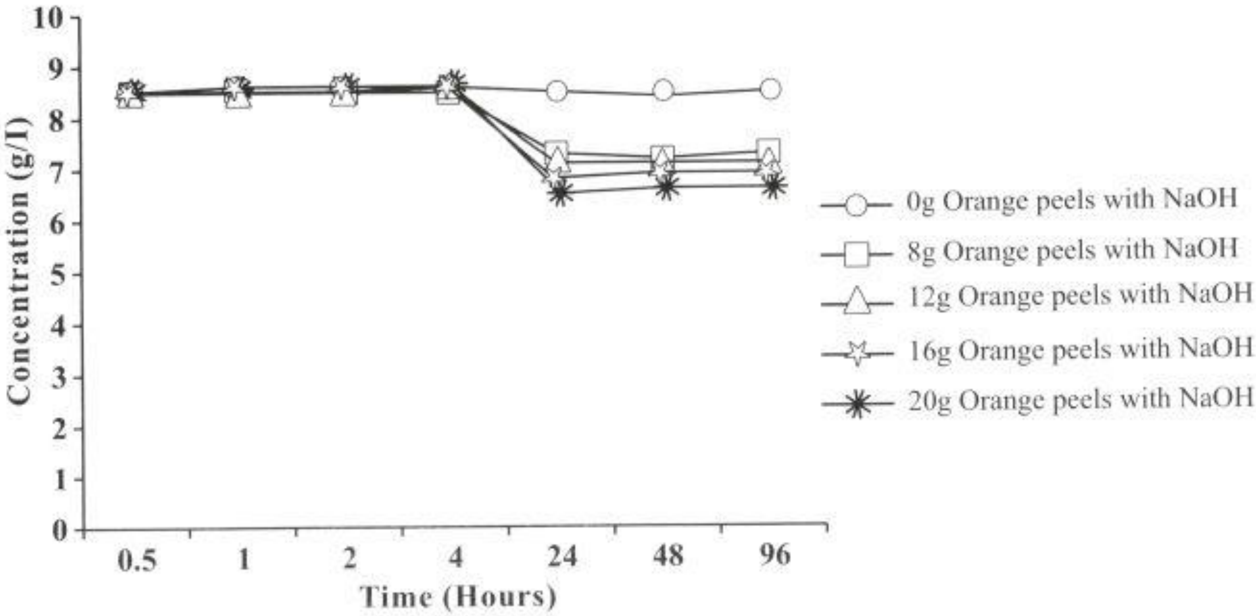

Figure 6: *Variation of pH over time for sewage*

The Total Suspended Solid increases with time on the surface water and decrease with time on the wastewater on the addition of the mixed absorbent for treatment as shown in Figures 7 and 8. The figures reveal that the substrates in the wastewater are been detoxified by the increased concentration of the mixed absorbent.

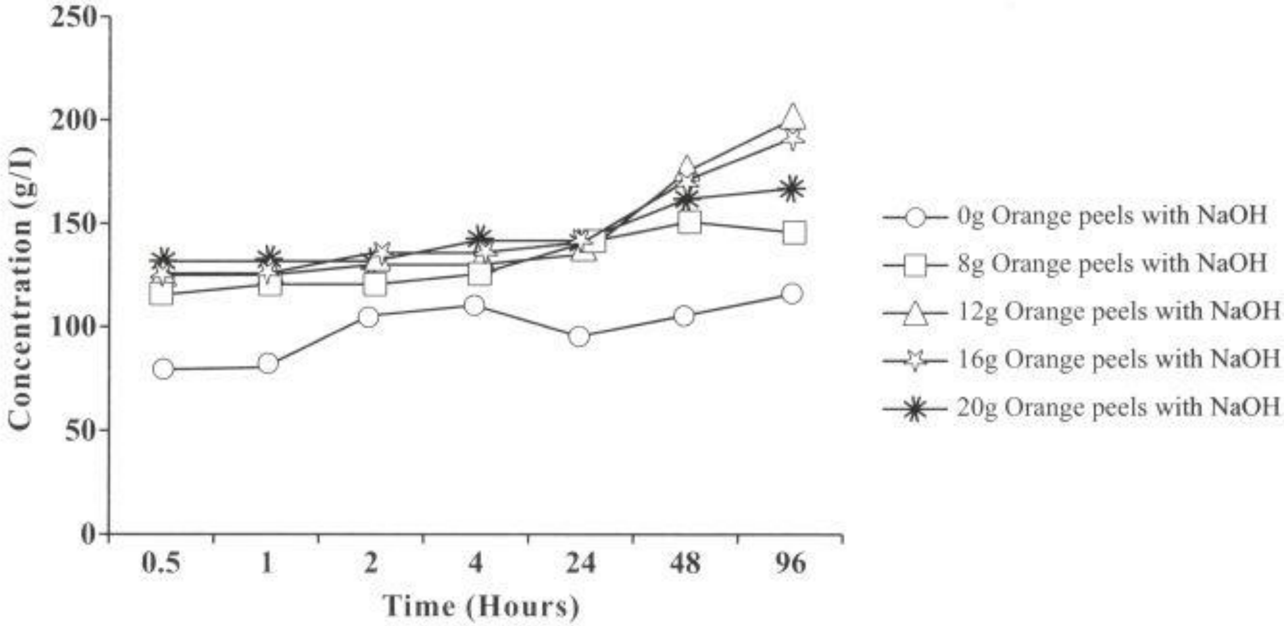

Figure 7: *Total Suspended Solid (TSS) values for River Water*

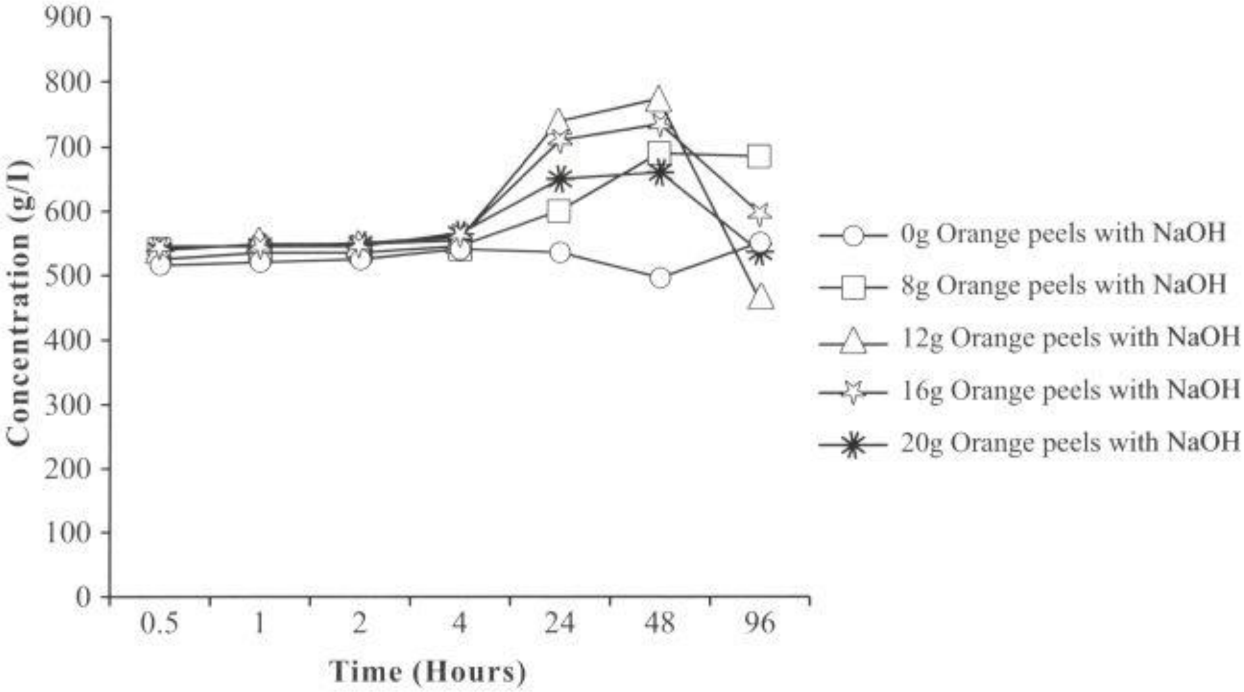

Figure 8: Total Suspended Solid (TSS) values for Sewage

The Coliform MPN result in Figures 9 and 10 indicates that water samples treated with mixed absorbent decrease with time on the addition of 8g, 12g, 16g, and 20g. At 96 hours the presence of coliform was almost zero. It indicates that the presence of coliform can be detoxified over time.

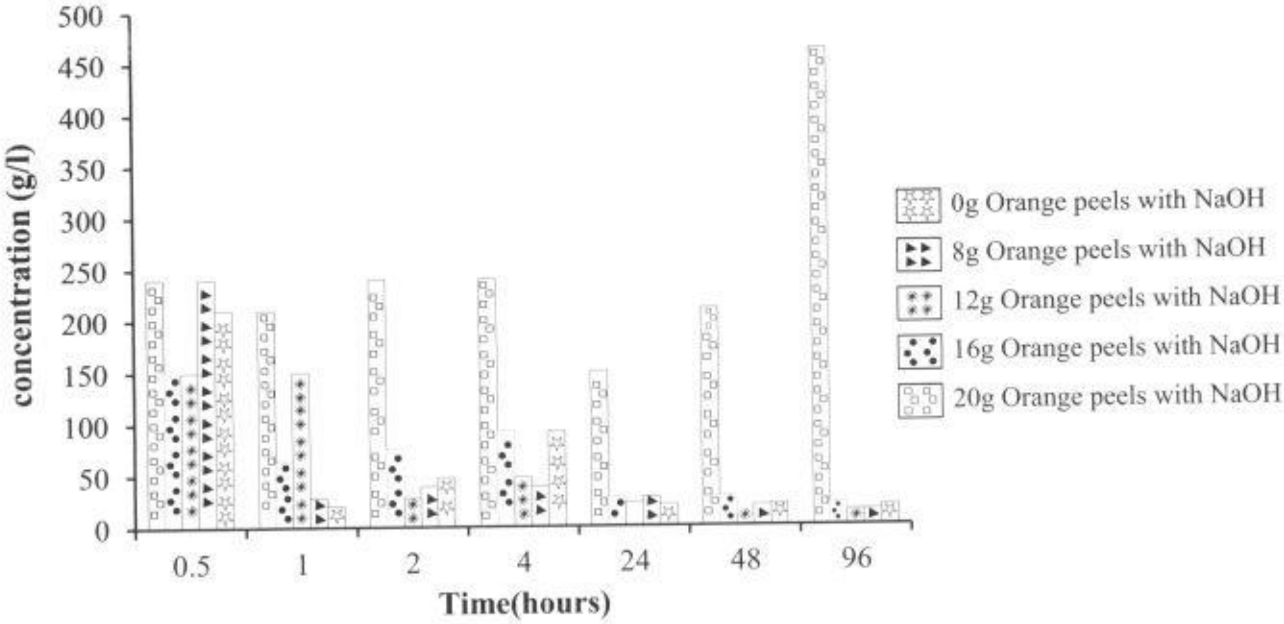

Figure 9: *River water value for Coliform MPN/100ml x10^{2}*

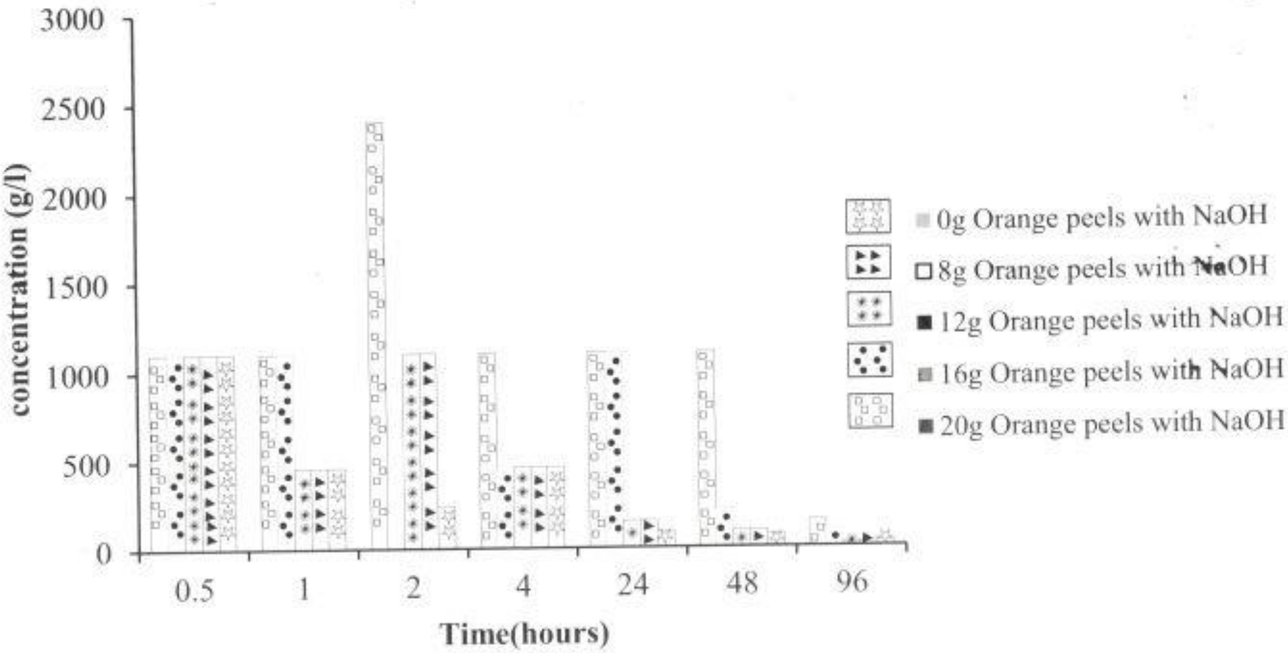

Figure 10: Coliform MPN/100ml x10^{4} Values for Sewage

At the addition of 0g of the mixed absorbent, the concentration of E-coli was indicated high at 24 hours test in the treatment of the wastewater, while that of the stream water varies randomly. At 8g and 20g additive of the mixed absorbent, E-Coli growth decreases with time in both samples (see Figures 11 and 12). The microbial pollutants were abated with the addition of absorbent. The use of the orange peel as a disinfectant, antioxidants, and phytotoxic effects as recorded by Erukainure *et al* (2016) cannot be eluded.

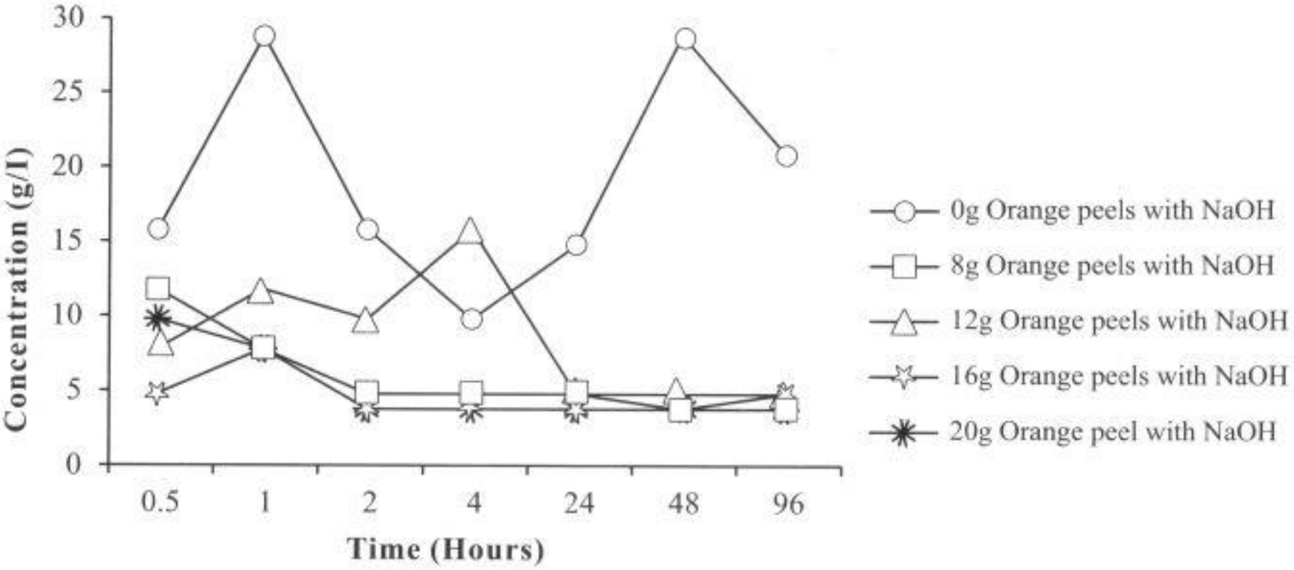

Figure 11: *E-coli MPN/100ml x10² values for River water*

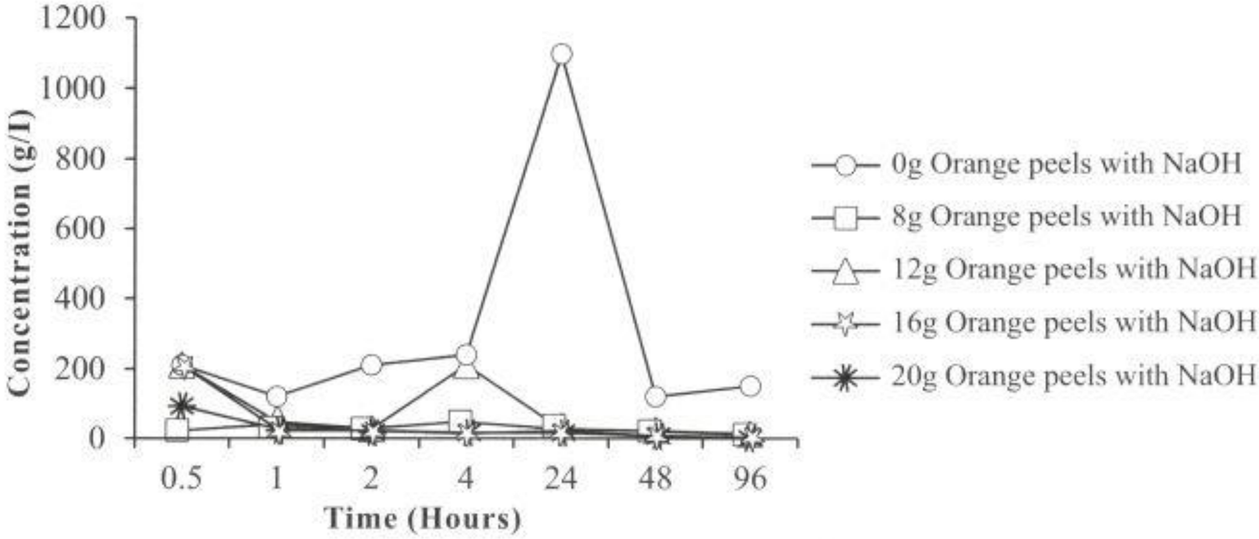

Figure 12: *E-coli MPN/100ml x10⁴ values for Sewage value*

Finally, the BOD is decreasing with time in the SW/WW on the addition of mixed absorbent as shown in Figures 13 and 14. This is an indication that the treatment is effective with time as the microbe decreases. The decrease was seen in Figures 13 and 14 also shows that the mixed absorbent absorbs the organic matters present in SW/WW, thus, removing the impurity, enhancing the strength and efficiency of the SW/WW.

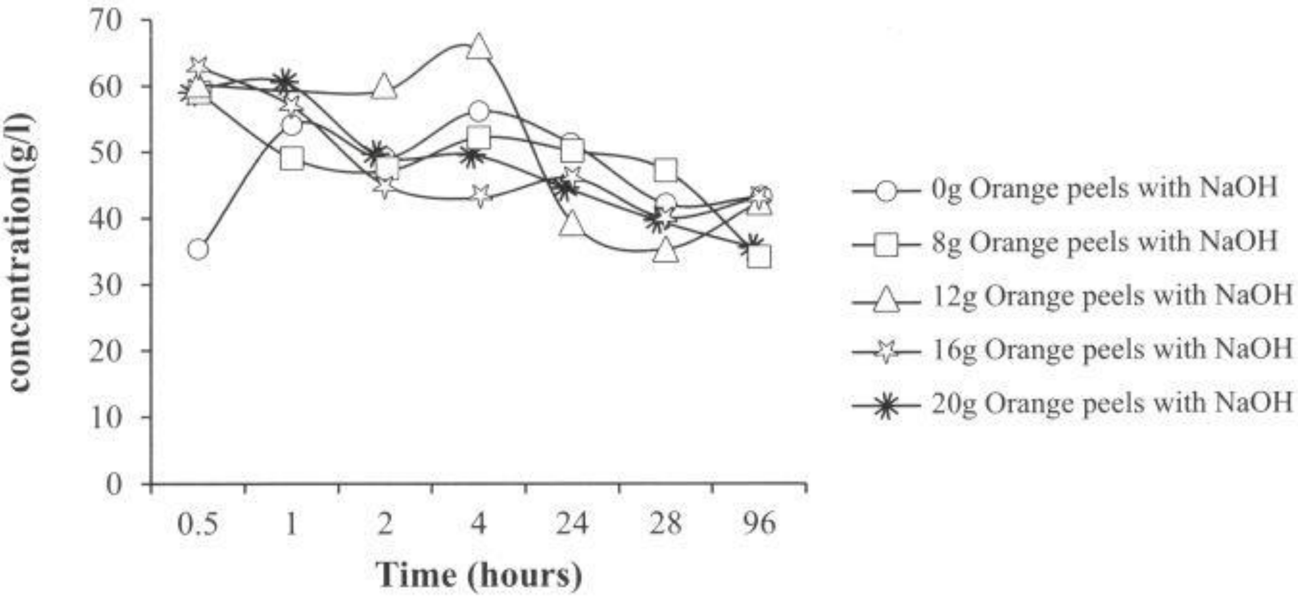

Figure 13: *Biochemical Oxygen Demand (BOD_5) Test Values for River water*

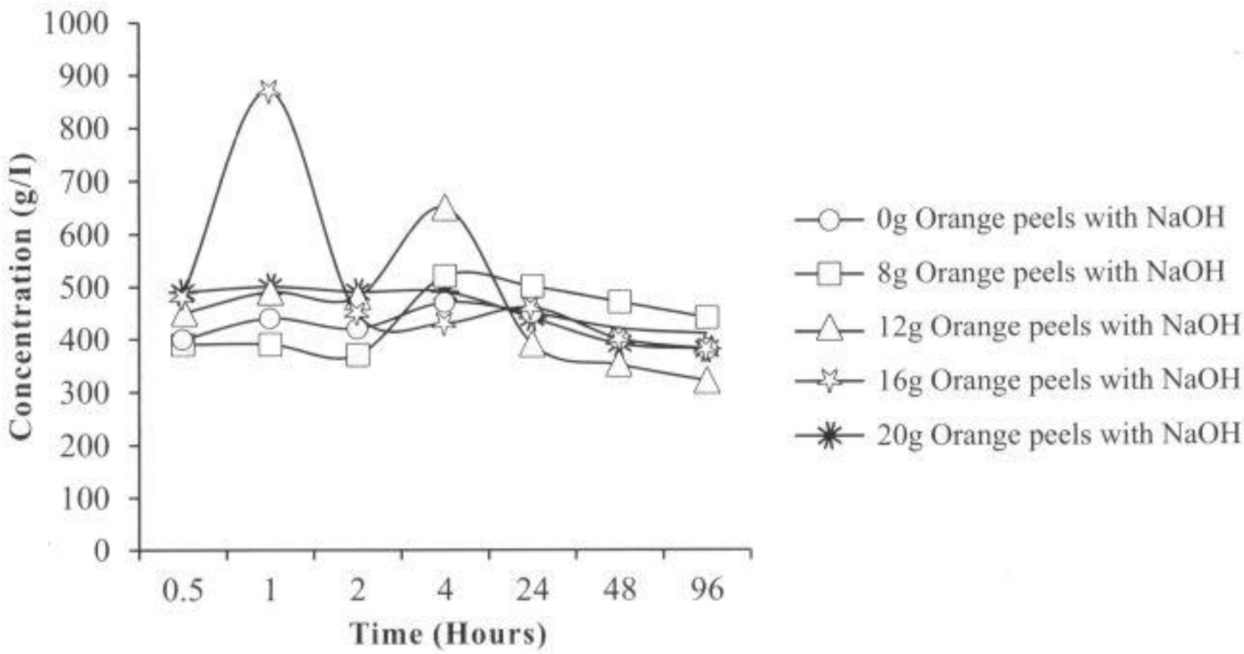

Figure 14: Biochemical Oxygen Demand (BOD_5) Test Values for Sewage

3. CONCLUSION

In the laboratory-scale studies, the data show that orange peels have considerable potential for eliminating impurities from aqueous solutions over a wide range of concentrations. The orange peels were activated by sodium hydroxide (NaOH) and added to both the surface water and the wastewater to determine parameters like; pH, Coliform MPN, E. coil MPN, Temperature, BOD, Total Suspendered Solid TSS, and Nitrite. The values were plotted with respect to time and observed that the water exhibited acceptable ranges of pH, Coliform, E. coli, TSS, BOD, etc. Comparing the two samples, this is a useful takeaway from the study but boundary limits are to be set for time and concentrations. Though, the microbes in the River water deduce faster than the wastewater. Finally, the conclusions made are that the orange peels mixed with NaOH as absorbent should be for economic value to the treatment of stream and sewerage water to reduce environmental pollution. Promoting this low-cost and affordable treatment would reduce the volume of solid waste and minimize blockages of drainages and waterways in our urban centers. It would also create an avenue to earn income for some actors with fruit and vegetable value chains.

RECOMMENDATION

This research work is of importance to public health Engineers and other specialists in environmental protection and control. Since orange peels are economical and affordable, it is commendable that the study should be repeated with wide ranges of the time and concentrations of the absorbent to come up with boundary limits that have economic value for societal adoption, especially in the rural area.

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