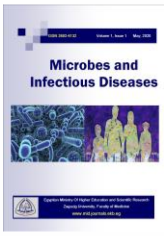
Microbes and Infectious Diseases 2022; 3(4): 1044-1051



Microbes and Infectious Diseases

Journal homepage: https://mid.journals.ekb.eg/

Original article

Antibacterial effects of natural adsorbent prepared from two local Sudanese agricultural waste mango seeds and date's stones and their uses in removal of contamination from fluid nutrient

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ARTICLE INFO

Article history:
Received 22 January 2022
Received in revised form 19 February 2022
Accepted 3 March 2022

Keywords:
E. coli
Shigella spp.
E. faecalis
Activated carbon
Date's stone

List of Abbreviations
AC: Activated carbon
BAC: Biological activated carbon
NOM: Natural organic matter
SPSS: Statistical Packages for Social Sciences

ABSTRACT

Background: The use of biologically activated carbon (BAC) in drinking water purification is reviewed. **Aim:** The study was aimed to determine the efficiency of natural adsorbent with antibacterial effects against the strains of *E. coli*, *Shigella* spp. and *Faecalis* bacteria which are found in stimulated water samples. **Methods:** This was an analytical laboratory based study. The study was carried out at laboratory of Ahfad University for Women at Omdurman in Khartoum state. Two samples of mango seeds and date's stone were used to carry out these experiments. Mango and date were brought from the local market (Sug El Arabi). The general process to produce activated carbon is based on carbonizing and activating the carbon aqueous precursor material. The powder was put in crucible and 1 gram of zinc chloride was added to it. It was incinerated at 350 ^{0}C for not less than 3 hours in an oven. It was cooled in a room temperature. **Results** Activated carbon prepared from mango seeds and date's stone was found to be very active as antibacterial against *E.coli*, *Shigella and E.faecalis* bacteria. The result showed zone of inhibition for each bacteria. The greater zone of inhibition was against *E.faecalis*done by both samples. The more effective sample in the three strains was AC from mango seeds. **Conclusions:** These antibacterial results are good indicators to use natural adsorbent in food processing, sugar purification and food industry.

Introduction

Activated carbon is broadly defined to include a wide range of amorphous carbon based materials prepared in such a way that they exhibit a high degree of porosity and an extended surface area [1].

Lu et al. [2] mentioned that proper granular activated carbon (GAC) selection could improve the performance of biological activated carbon (BAC) filters through a combination of adsorption and biodegradation, while the GACs used in BAC filters are now mainly selected

DOI: 10.21608/MID.2022.117625.1238
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according to adsorption function, ignoring biodegradation.

The use of BAC in drinking water purification is reviewed. In the past BAC is seen mostly as a polishing treatment. However, BAC has the potential to provide solution to recent challenges faced by water utilities arising from change in natural organic matter (NOM) composition in drinking water sources - increased NOM concentration with a larger fraction of hydrophilic compounds and ever increasing trace level organic pollutants. BAC can offer many advantages by removing hydrophilic fraction and many toxic and endocrine compounds which are not otherwise removed. BAC can also aid the other downstream processes if used as a pre-treatment [3].

The most common use of activated carbons is in adsorption processes, because the adsorbent presents the necessary physicochemical characteristics that allow it to capture substances that are desired to be removed from systems in gaseous or liquid phases [4, 5].

Adsorption is a method widely used for the purpose of removing such compounds, due to its low cost of implementation, high efficiency, and easy operational design [6]. Recent research has shown that this process, when carried out in activated carbon, allows the carbon to adsorb at least 50% of the initial concentration of contaminants present in the water [7, 8].

Fluid nutrients are like water, juices and milk. Water is very important for life. So keeping water save from microbial contamination is very important to prevent their borne diseases. We can reduce these contaminations by application of natural adsorbent (activated carbon) because it is easily prepared from natural sources and low cost.

The study aimed to evaluate the efficiency of natural adsorbent such as activated carbon in reduction of antibacterial contamination from fluid nutrient

Materials and Methods

Study design

This was an analytical laboratory based study. The study was carried out at laboratory of Ahfad University for Women at Omdurman in Khartoum state.

Two samples of mango seeds and date's stone were used to carry out these experiments.

The mango and date were obtained from the local market Sug El Arabi. The seeds and the stones were taken from the fruit .They were cleaned, removed from the foreign materials then ground to a powder using an electric grinder to pass a 0.5 mm screen.

Methods

Preparation of activated carbon (adsorbent)

The general process to produce activated carbon is based on carbonizing and activating the carbon aqueous precursor material. The powder was put in crucible and 1 gram of zinc chloride was added to it. It was incinerated at 350 ^{0}C for not less than 3 hours in an oven. It was cooled in a room temperature. The resulting ash was considered as activated carbon. This activated carbon was used in solubility test, pH, carbon content, ash content, moisture content and reduction of methylene blue. While in the antibacterial test activated carbon was used after treatment by copper sulphate [9, 10].

Method of antibacterial sensitivity test

For this purpose, disk diffusion method was used. Stored isolates bacteria (*Escherichia coli (E.coli), Shigella spp.* and *Enterococcus faecalis (E.faecalis)*) were recultured on nutrient agar . A suspension from one-day-old bacterial cells of each isolate was prepared with 2ml of agar broth equivalent to the McFarland turbidity standard. The suspensions were spread on to the surface of the Mueller Hinton agar with sterile cotton swabs. The plates were briefly dried and then the antibiotic disks of powdered activated carbon was added to each plate and incubated aerobically at 37 ºC for 3-5 days. One plate with powdered activated carbon untreated by copper sulphate was used as a control. The inhibition zone diameters were measured in milli meters with a ruler. Resistance determined by a zone of growth inhibition diameters. Greater zones of complete growth inhibition indicated the presence of susceptible strains. The procedure repeated for cultures that were defined as resistant.

Data analysis

Using Statistical Packages for Social Sciences (SPSS) program analyzed results. The data collected were statistically analyzed to generate Pearson correlation coefficient (p-value) using Statistical Package for Social Sciences (IBM SPSS Statistics 21) to compare the values observed. All information gathered via data master sheet then coded into variables involving Chi square tests were used to present results, a *p* value of less than 0.05 was considered as statistically significant.

Results

Mongo seeds were the most effective against *E. coli* (20mm), while date showed less activity (18mm). On the other hand, the activated carbon on the control plate without copper sulphate did not exhibit any antibacterial activity **(Figure 1)**. (p> 0.05)

Treated activated carbon from mongo seeds and date's stones showed variable antibacterial activity against *Shigella spp.* the activated carbon from mongo seeds inhibited mostly the growth rate of *Shigella spp.* (23mm) than activated carbon from date showed (20mm) **(Figure 2)** (p< 0.05).

Figure 3 shows that *E. faecalis* was senstive to our treated activated carbon from both mango and date. The inhabition zones were 25mm and 23mm respectively (p < 0.05).

Figure 4 shows that there is correlation between treated activated carbon from mango seeds and *E. coli* and it is a significant correlation (p > 0.05).

Figure 5 shows that there is correlation between treated activated carbon from date's stones and *E. coli* and it is not a significant correlation (p > 0.05).

Figure 6 shows that there is correlation between treated activated carbon from mango seeds and *Shigella spp.* and it's not a significant correlation. (p < 0.05).

Figure 7 shows that there is correlation between treated activated carbon from date's stones and *Shigella spp.* and it is a significant correlation (p < 0.05).

Figure 8 shows that there is correlation between treated activated carbon from mango seeds and *E .faecalis* and it is a significant correlation (p < 0.05).

Figure 1. Showing that antibacterial activity of AC from Mango seeds and Date's stones against *E. coli*.

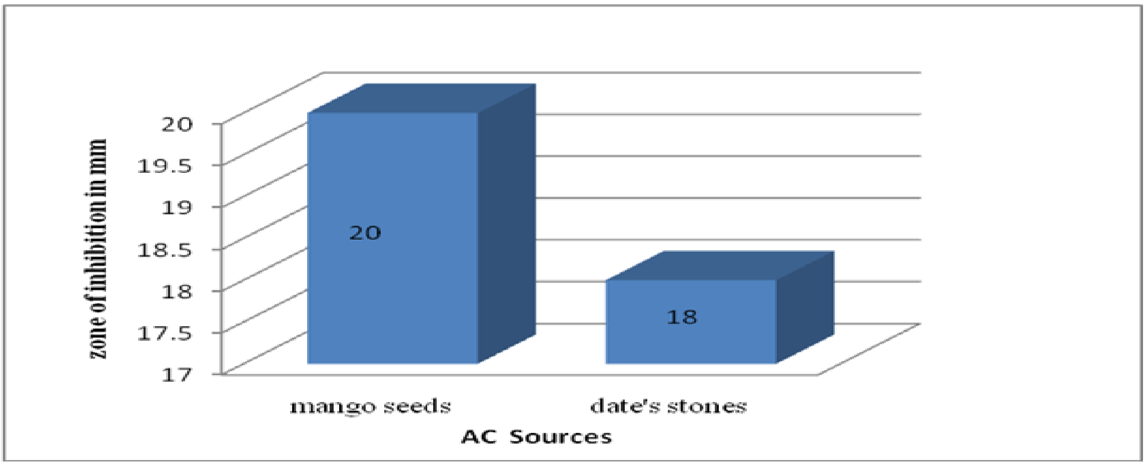


Figure 2. Showing that antibacterial activity of AC from mango seeds and date's stones against *Shigella spp*.

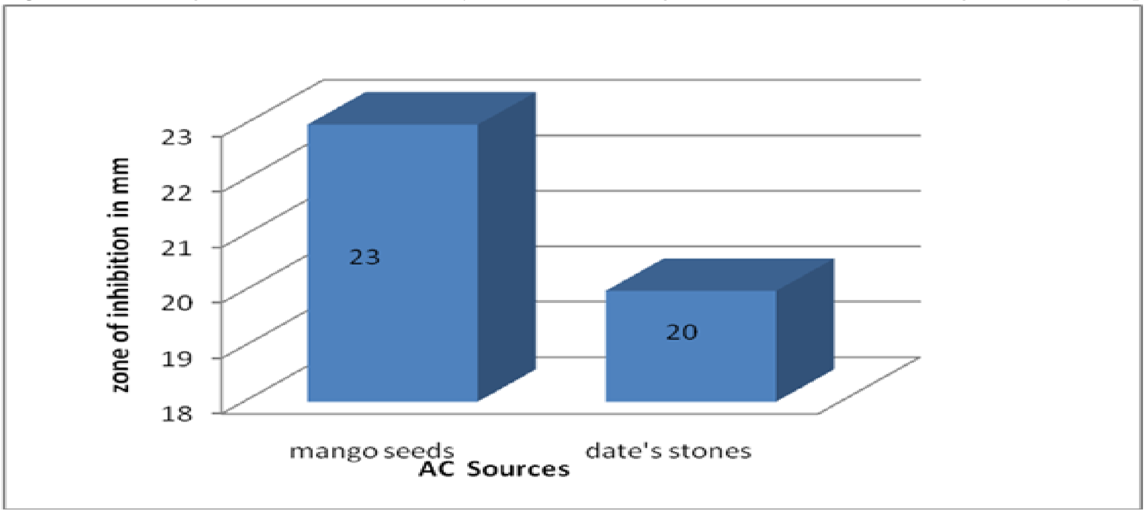


Figure 3. Showing that antibacterial activity of AC from mango seeds and date's stones against *E. faecalis*.

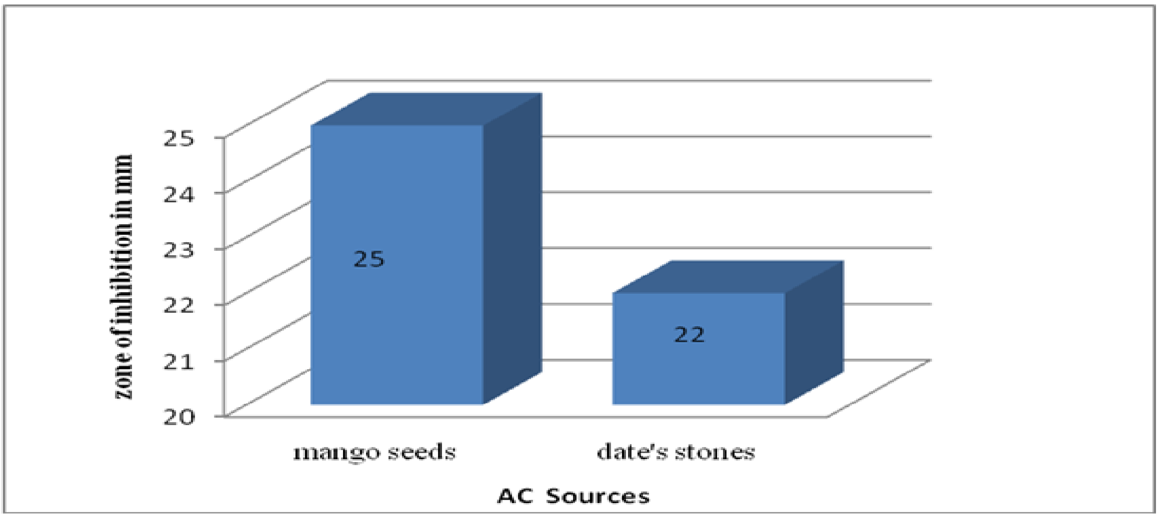


Figure 4. Correlation between treated AC from mango seeds and *E.coli*.

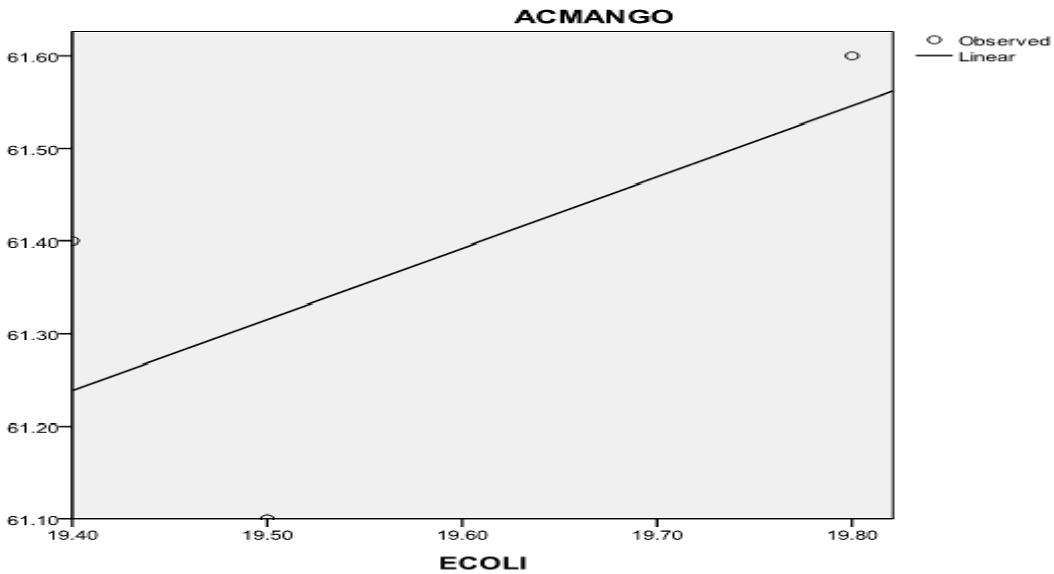


Figure 5. Correlation between treated AC of date's stone and *E.coli*.

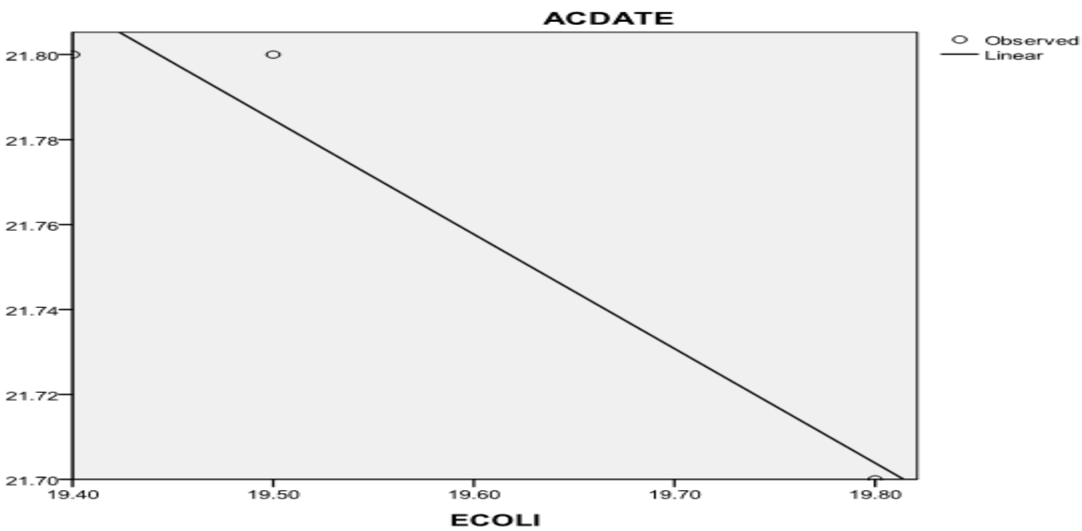


Figure 6. Correlation between treated AC of mango seeds and *Shigella spp.*

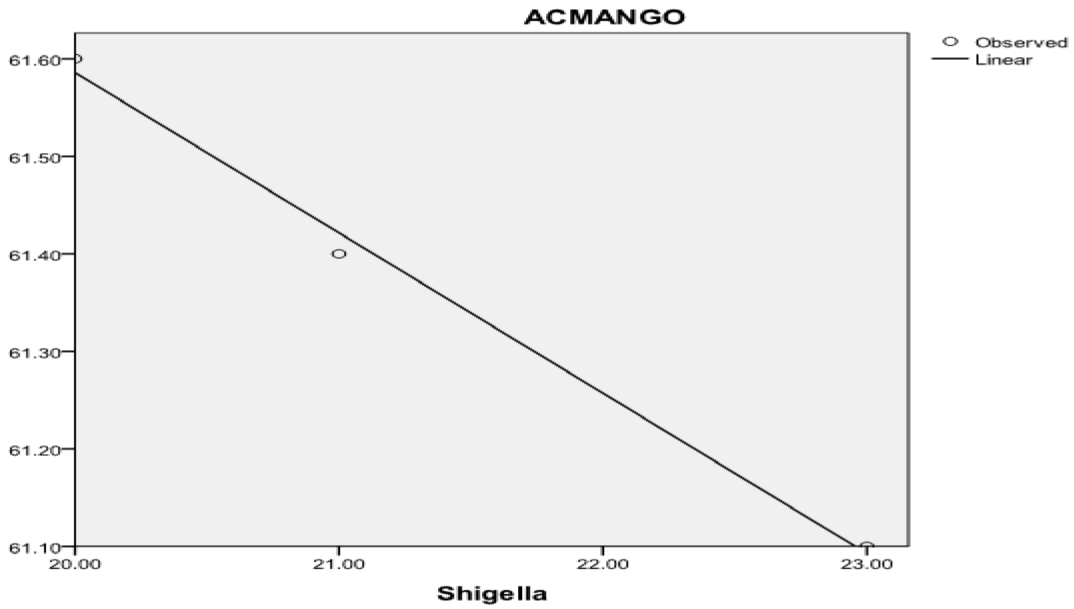


Figure 7. Correlation between treated AC of date's stones and *Shigella spp.*

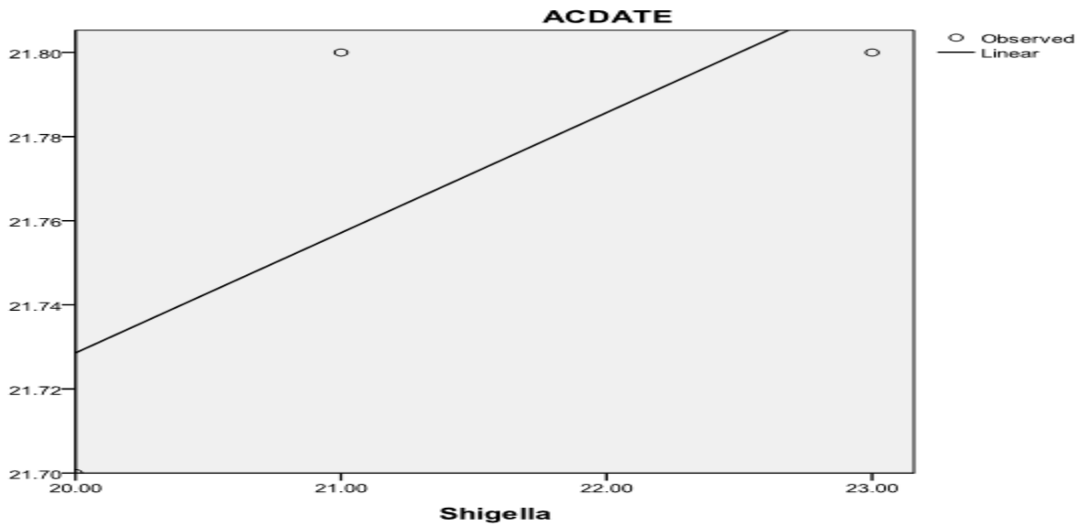


Figure 8. Correlation between treated AC of mango seeds and *E.faecalis.*

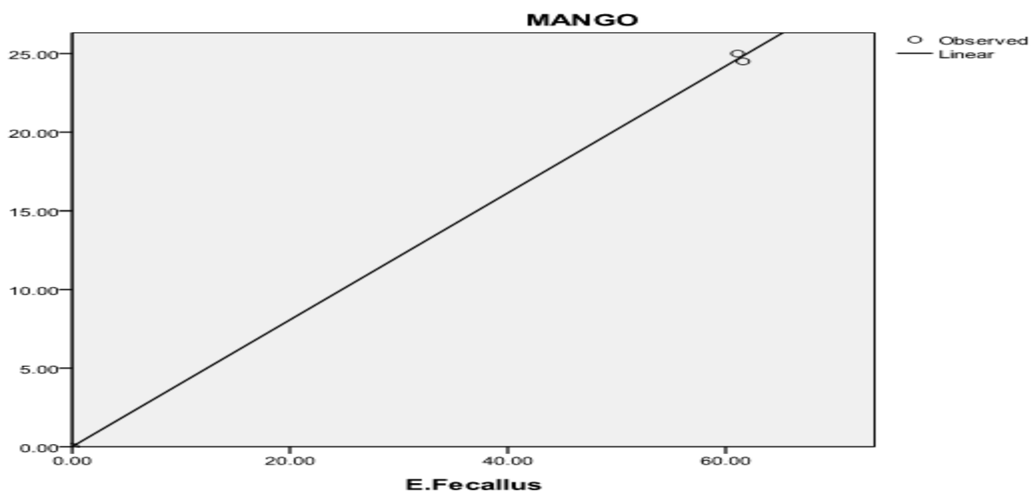
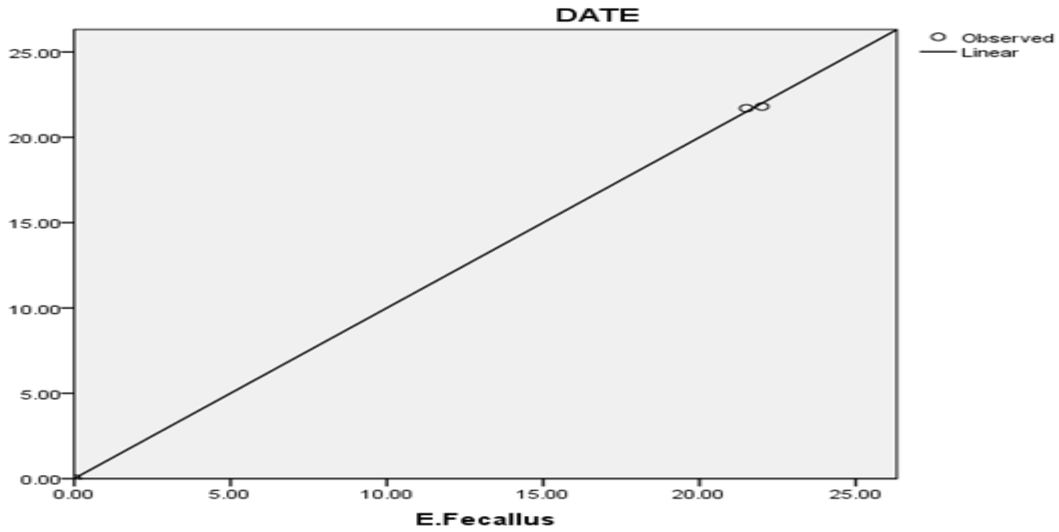


Figure 9. Correlation between treated AC of date’s stones and *E.faecalis.*



Discussion

Activated carbon from mongo seeds and date’s stone treated by copper sulphateexhibit variable antibacterial activity against *Escherichia coli, E. faecalis, and Shigella spp.*

Mongo seeds were the most effective against *E. coli* (20mm), while date showed less activity (18mm). On the other hand, the activated carbon on the control plate without copper sulphate did not exhibit any antibacterial activity (Figure 1).

Our result is inagree with Won Chun result which reported that treated activated carbon showed great effect aginst *E. coli* [11].

In this study, treated activated carbon from mongo seeds and date’s stones showed variable antibacterial activity against *Shigella spp.;* the activated carbon from mongo seeds inhibited mostly the growth rate of *Shigella spp.* (23mm) than activated carbon from date showed (20mm) (Figure 2).

Our control plate activated carbon without copper sulphate did not exhibit any antibacterial activity. Subhasish and his colleagues who study the potential activity of activated carbon from mango and date as antibacterial against *Shigella spp.*, found that only treated activated carbon have antibacterial effect against *Shigella spp*. [12; 13].

Figure (3) showed that *E. faecalis* was senstive to our treated activated carbon from both mango and date. The inhabition zones were 25mm and 23mm respectively.

Our control plate activated carbon withoutcopper sulphate as other tested bacteria, did not exhibit any antibacterial activity. Subhasish and his colleagues also reported that treated activated carbon have great effective against *E .faecalis* [12;13].

Figure (4) shows that there is correlation between treated activated carbon from mango seeds and *E. coli* and it is a significant correlation.

Figure (5) shows that there is correlation between treated activated carbon from date's stones and *E. coli* and it is not a significant correlation.

Figure (6) shows that there is correlation between treated activated carbon from mango seeds and *Shigella spp.* and it’s not a significant correlation.

Figure (7) shows that there is correlation between treated activated carbon from date's stones and *Shigella* s*pp.* and it is a significant correlation.

Figure (8) shows that there is correlation between treated activated carbon from mango seeds and *E. faecalis* and it is a significant correlation.

Figure (9) shows that there is correlation between treated activated carbon from date's stones and *faecalis* and it is a significant correlation.

Yu et al. mentioned that an increasing number of water purification plants use granular activated carbon filtration as an advanced treatment technology. One of the main constraints of carbon filtration is bacterial leakage, which can impact public drinking water safety. *Enterococcus faecalis*, commonly detected in natural water, was employed as the target bacteria for investigating the mechanism of deposition and migration of bacteria in granular activated carbon medium. The *E. faecalis* penetration curve was in accordance with the van der Waals force and electrostatic repulsion force under different conditions [14].

Tobin et al. reported that three activated carbon filters for point-of-use water treatment were tested in laboratory revealed that total coliform bacteria were found to persist and proliferate on the filters for several days after transient contamination of the influent water. *Pseudomonas aeruginosa* was recovered from the effluents of all filters at some time during the tests [15].

Limitations of the study

Few sample size, no antibiotic disks prepared from powdered activated carbon.

Conclusions

Activated carbon prepared from mango seeds and date's stone was found to be very active as antibacterial against *E. coli, Shigella* and *Faecalis* bacteria. The result showed zone of inhibition for each bacteria. The greater zone of inhibition was against *E. faecalis* done by both samples. The more effective sample in the three strains was AC from mango seeds. So it is effective to be used as antibacterial. These antibacterial results are good indicators to use natural adsorbent in food processing, sugar purification and food industry.

Declarations

Ethics approval and consent to participate: Not applicable.

Consent for publication: Not applicable.

Availability of data and materials

The data sets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

Authors declare that they have no competing interests.

Funding: Not applicable.

Authors' contributions

NAE and NAW conceived the design and carried out the experiments. AAI obtained, analyzed and interpreted the data. SKW and SIAE wrote and revised the manuscript. AAI provides financial support for all experiments. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

Acknowledgements: Thanks for all participants involved in this research.

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