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Examining the Role of Sponge Gourd Dust as a Natural Nalidixic Acid Adsorbent: An Analysis of Removal Effectiveness

***Abstract*: This study explores Nalidixic acid (NAL), a former treatment for gram-negative bacterial urinary tract infections. Nalidixic acid can pollute water, harm aquatic life, and promote antibiotic resistance. This research is looking into using the dust of the sponge gourd (*Luffa cylindrica*) (SG) as a natural adsorbent for NAL. It has observed that NAL was adsorbed by SG in FTIR study by changing bond pattern. Removal efficiency of NAL by SG is 52.6%. So, SG can be used as potential antibiotic adsorbent.**

Keywords: Sponge Gourd, Nalidixic acid, Bioadsorbents, FTIR, Removal efficiency, Bioremediation

Antibiotics, such as Nalidixic acid, are essentially minuscule molecular builders that interfere with the bacterial genome's creation. Its primary focus on DNA synthesis is like possessing a master key to unlock the mysteries of the bacterial realm. It is used in the treatment of various infectious diseases like urinary tract infections, respiratory infections, sexually transmitted diseases, acute bronchitis, and sinusitis[1]. Nalidixic acid in order to treat bacterial infections, antibiotics are essential. Quinolones' broad-spectrum activity makes them noteworthy. They stop bacterial replication by targeting and inhibiting bacterial DNA gyrase, which is akin to a superpower. It resembles putting a wrench into their equipment. The idea of these medications finding their way into the environment is both intriguing and concerning. The different routes they follow—from sewage sludge and landfill leachate to human and animal waste—highlight the intricate course antibiotics take outside of the clinical context. Antibiotic residues' effects on the environment are undoubtedly a problem that has to be carefully managed and given careful consideration.[2]

It is reported that amoxicillin residue, Ceftriaxone (CEFT) residue present in mastitis milk and acts as genotoxic agent[3]

It was removed from pure pharmaceutical formulations because to issues with its moderate solubility, adverse effects, and low absorption. Antimicrobial resistance also emerged during this time. Newer, better active pharmaceutical components with better pharmacokinetic qualities, decreased adverse effects, and increased efficacy replaced it.[4]Several methods such as the direct UV photolysis, ozonation process, solar photoelectron-Fenton bio sorbent photocatalytic process and adsorption- process have been employed for the removal of MNZ from aqueous solutions. In the water treatment field, luffa sponge fibers have been used as an effective adsorbent in the removal of heavy metals and dyes from contaminated water due to its fast adsorption kinetics, large surface area, and high stability properties Therefore, Luffa has been used as a natural bio-adsorbent inthe removal of toxic metals and dyes such as Pb2+ ions methylene blue dye,copper, oil and malachite green phenol, cationic surfactant, lanthanide many other toxic metals and dyes from contaminated water[3].

So, objectives of this study areto investigate the potential of Sponge Gourd (*Luffa cylindrica*) as an adsorbent for Nalidixic Acid and assessing the effectiveness of Sponge Gourd in reducing Nalidixic Acid contamination in water systems.

Material and Methods

Preparation of Nalidixic acid stock solution: The stock solution was prepared by dissolving the pure powder of Nalidixic acid in deionized water. For that 0.005 gram of powder was added to 10 ml of distilled water[5].

Processing of Sponge Gourd: Firstly, luffa fibres were chopped into little pieces, repeatedly cleaned with tap water to get rid of pollutants and dust attached, and then dried for 24 hours at 100 degrees Celsius in an air oven. To be used later, the dried luffa fibres were ground into a fine powder with the help of mortar and pestle.[6]

Treatment of Sponge Gourd Fibre with Nalidixic Acid: Prepared Nalidixic solution was left to soak with sponge gourd , which was kept for 2 hours. Afterthat further procedure was done.

Characterization of Sponge Guard

Fourier-transform infrared spectroscopy was used to test the change in the chemical structure of sponge gourd over a range of 4000–400 cm1 at room temperature with a resolution of 4 cm1.

Removal Efficiency of Nalidixic Acid: The measurement of NAL concentration in this study was carried out using a UV–visible spectrophotometer (model DR 5000) at 340 nm wavelength according to the Standard Methods for the Examination of Water and Wastewater[7]

$$\text{Removal Efficiency (\%)} = \left(\frac{C_0 - C_e}{C_e}\right) \times 100$$

where Co and Ce are the initial and final value of Nalidixic acid.

Results

Determination of the structural characteristics of the adsorbent: Dust form has prepared.

Removal efficiency of Nalidixic acid by SG: After 120 min using adsorbent dose, the removal percentage was 52.62±2.6 (Fig. 1). Generally, the ideal adsorbent adsorbs contamination at low contact times with high removal performance. The initial concentration is another important factor which affects the amount of adsorption of the NAL from the solution. The NAL elimination efficacy decreased by increasing initial concentrations.

Determination of the structural characteristics of the adsorbent after NAL absorption:To study the nature of the functional groups, present on the surface of the samples, the FTIR analysis was carried out (Fig. 2). Fig. 2 shows the results of FTIR measurements taken for the untreated sponge guard and absorbed with nalidixic acid (Nal) to mitigate Nal from the waste water. To study the nature of the functional groups, present on the surface of the samples, the FTIR analysis was carried out. Figure 1(a) shows the results of FTIR measurements taken for the untreated sponge guard and absorbed with nalidixic acid (Nal).Peak at 3269 cm-1 is associated with the O-H (hydroxyl) group, often found in alcohols and phenols. A lower transmission percentage at this wavenumber suggests higher absorption by the hydroxyl group.2361 cm-1 is corresponds to the Ca"C triple bond, typically found in alkynes. A lower transmission percentage at this wavenumber indicates higher absorption by the triple bond.

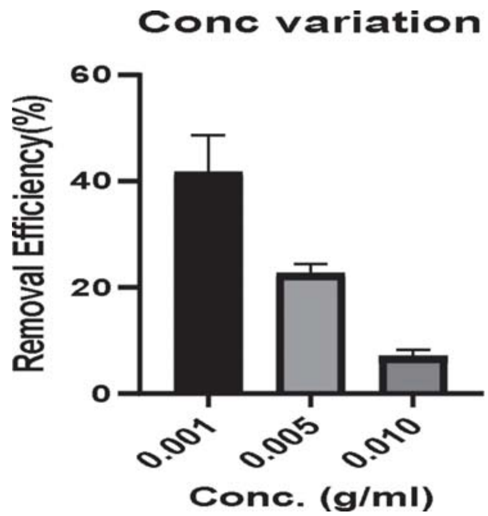

Fig. 1: Removal Efficiency of Nal at Different Concentration of SG

Another peak at 1647 cm-1 is related to the C=O (carbonyl) group, commonly present in ketones and aldehydes. A lower transmission percentage at this wavenumber suggests higher absorption by the carbonyl group. 1018 cm-1 is associated with the C-O stretching vibration, indicative of ether or alcohol functional groups. A lower transmission percentage at this wavenumber implies higher absorption by the C-O bond.

Effect of Adsorbent Dosage: Removal efficiency of Nalidixic acid (1ug/ml) by Sponge gourd is 52.6%±2.61 at 120min when dose conc. of SG is 0.001g/ml. Removal

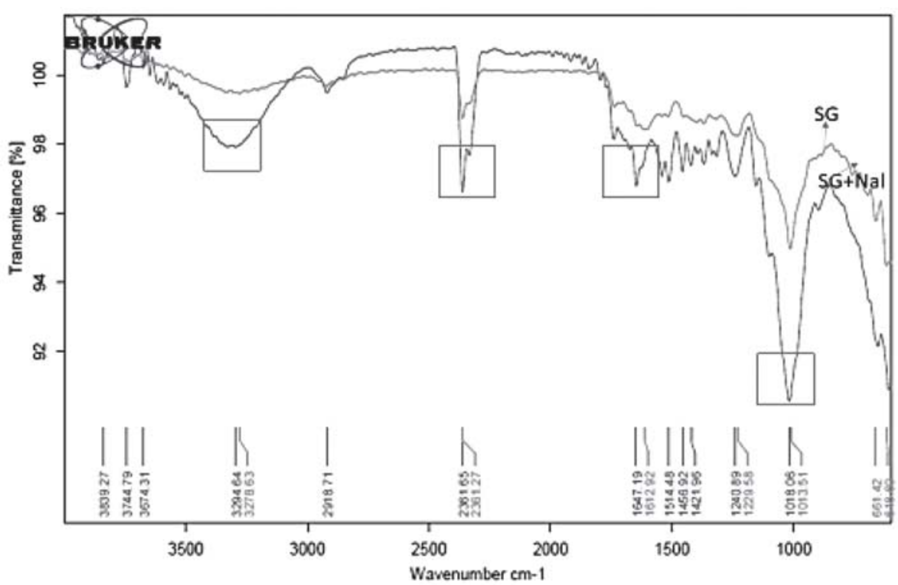

Fig. 2 : FTIR Spectra of Nalidixic acid with Sponge Gourd

efficiency of Nalidixic acid (1ug/ml) by Sponge gourd is 41.5% ± 7.11 at 120min when dose conc. of SG is 0.001g/ml (Fig. 3)

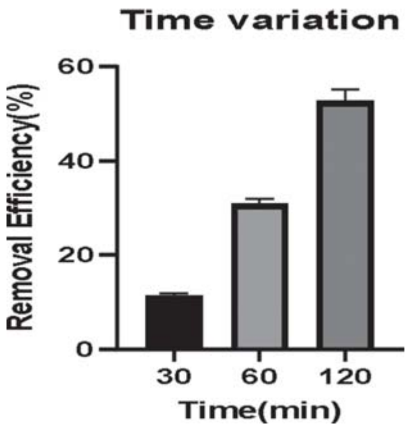

Fig. 3: Removal Efficiency of Nal at Different Time Variation

Discussion

Bioadsorbents like microalgae, Terminaliacatappa leaves, and siris seed pods have demonstrated up to 98.74% efficiency in removing antibiotics such as tetracycline, dicloxacillin, and nitromidazole. These studies highlight the effectiveness of adsorption in targeting antibiotic-resistant genes (ARGs) and bacteria, thus addressing the critical issue of antibiotic residues in the environment. Using bioadsorbents for adsorption appears to be a promising method for mitigating antibiotic contamination and limiting the spread of antibiotic resistance in aquatic environments. In our study, it has observed that Removal efficiency of Nalidixic acid by SG was 52.62±2.6.

A more detailed study on the composites with both in natural sponge gourd fibers was obtained using the FTIR technique, as shown in Fig. 2. The band at 3269.4 cm". The band at 2918 cm"1 The bands at 2918, 2953, and 2959 cm"1 are associated with C-H stretching and the band at 2923 cm"1 refers to the CO2 from the atmosphere of the analysis. 2361 cm"1 corresponds to the for SG could be attributed to O–H vibration in the H2O molecule in natural components, The band at 1018 cm"1 is related to C-H bending symmetric in the fibers, 1631 cm"1 (C1AOAC4), 1429 cm1 (OAH groups) peak at 1054 cm"1 (CAO stretching vibrations), 1029 cm"1 and 896 cm"1 associated with b-glycosidic linkages between glucose units The characteristic absorption peaks of natural-Luffafibers are observed at 3334 cm"1 (OAH stretching), 2898 cm"1 (CH2 groups of cellulose)[3]

The purity of the crystalline cellulose is indicated by the bands at 1023 and 896 cm"1, while the 1023 cm"1 band is caused by stretching of the C-O bonds and alteration of the alkoxide groups. The band at 896 cm"1 is linked to the axial strains of C-O-C bonds and â-glycosidic bonds existing in the glucose groups of the cellulose. It can be seen that there were changes in the wavelengths of the FTIR spectra after the silanization treatment, indicating stretching between the Si-O-Si bond and the Si-O-cellulose bonds. The bands at 901 and 1157 cm"1 (Fig. 2) confirm the binding of cellulose to silane, as well as the stretching of the bands that are visible at 1023 cm"1. The bands at 1238 to 1319 cm"1 also confirm the binding of Si-O-Si and Si-O-cellulose. Nal treatment caused some changes in the spectra. In the range of 2361 cm-1, overlapping bands of O–H and N–H stretching vibrations were observed for all the modified samples. Absorption at wavenumbers of 2,930 cm1 for SG and 2,941 cm1 for NAL are attributed to the aliphatic C–H interaction with the surface of the adsorbent. Nalidixicacid displays the presence of one strong peak at 2,360 cm1 which corresponds to the C–C stretching vibrations in alkyne groups. Thus, the results of FTIR showed that amine groups were well coated on active carbon.[5]

Conclusions

The results of this investigation demonstrate that using sponge gourd raises the adsorbent's concentration and improves the efficiency of nalidixic acid removal. Sponge gourds have demonstrated a noteworthy ability to remove Nalidixic acid from aquatic solutions, indicating that they may find wider uses in laboratory and industrial water and wastewater treatment. The results of this study demonstrate the potential of using naturally occurring bioadsorbents, such as sponge gourd, in bioremediation processes to address antibiotic pollution and safeguard the public's and the environment's health.

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