Comparison of TPH Contaminant Removal Efficiency Using Different Bioadsorbents

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Abstract- This study investigates the effectiveness of various bioadsorbents—specifically sun-dried plantain stem fiber, room-dried palm fruit fiber, and room-dried banana stem fiber—in the removal of total petroleum hydrocarbons (TPH) from contaminated water. Conducted through a series of batch operations, the research examines the impact of temperature on contaminant removal efficiencies. Results indicate that sun-dried plantain stem fiber achieved the highest TPH removal rate of 63.21% at 45°C, outperforming both room-dried palm fruit fiber (61.78% at 45°C) and room-dried banana stem fiber (55.33% at 45°C). The findings underscore the potential of these natural bioadsorbents for effective water treatment, with temperature playing a crucial role in optimizing contaminant reduction.

Indexed Terms- Contaminants, Comparison, Bioadsorbent, TPH, Remediation

I. INTRODUCTION

Water contamination, particularly from total petroleum hydrocarbons (TPH), poses significant environmental and health risks. The need for effective and sustainable treatment methods is more critical than ever. Bioadsorption has emerged as a promising technique for removing organic pollutants from aqueous solutions, utilizing naturally available materials that can serve as bioadsorbents. Among these materials, agricultural waste products such as plantain stem fiber, palm fruit fiber, and banana stem fiber have shown potential due to their availability and low cost [1-4].

Previous studies have highlighted the capacity of various plant-derived materials to adsorb contaminants, revealing their potential in water treatment applications. This research aims to compare the percentage removal efficiencies of TPH using different bioadsorbents while considering the influence of temperature on their performance. The first phase of the study focuses on the effectiveness of sun-dried plantain stem fiber, which has demonstrated significant bioadsorbent properties. The second phase assesses room-dried palm fruit fiber, further contributing to the understanding of temperature's role in enhancing contaminant removal [5-8].

Through a systematic approach, this study not only evaluates the performance of these bioadsorbents but also establishes a comparative framework that may inform future applications in environmental remediation. The results are expected to provide insights into optimizing the use of agricultural waste products in treating contaminated water, ultimately contributing to more sustainable water management practices [9-12].

II. METHODOLOGY

- Materials

Bioadsorbents: Sun-dried plantain stem fiber, room-dried palm fruit fiber, and room-dried banana stem fiber.
Contaminants: Total petroleum hydrocarbons (TPH) standard solutions.
Equipment: Batch reactors, analytical balance, temperature-controlled water bath, spectrophotometer.

- Preparation of Bioadsorbents

Collection and Drying: Collect plantain stems, palm fruits, and banana stems. Wash to remove impurities, then dry under sunlight or in a controlled environment until moisture content is minimized.

Grinding: Grind the dried materials to a uniform particle size for enhanced adsorption efficiency.

- Batch Adsorption Experiments

Prepare a series of batch reactors for each bioadsorbent type. Label as Setup 1 (Plantain Stem), Setup 2 (Palm Fruit), and Setup 3 (Banana Stem).

Model of Freundlich Isotherm

Recalling the model of Freundlich isotherm, thus:

$$q_e = K_f \, {}^{1}/_{n} \, C_e \quad (4)$$

Taking the logarithm of the equation (4) we have

$$\text{Log } q_e = \log K_f + \frac{1}{n} \log C_e \quad (5)$$

In this case ${}^{1}/_{n}$ is the slope and log K_f is the intercept when logq_e is plotted with logC_e and $K_f$is the Freundlick constant and n represents heterogeneity in terms of adsorption energy of adsorbent surface.

III. RESULTS AND DISCUSSION

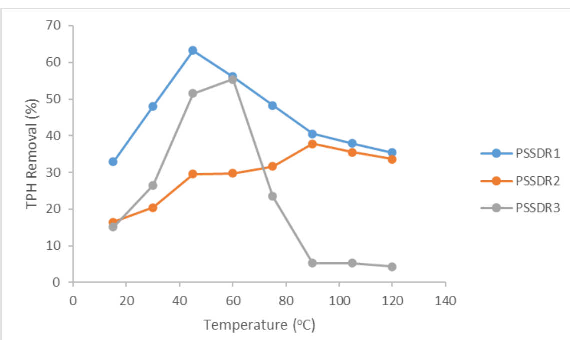

Figure 1: Comparison of Percentage Removal of TPH (Contaminants) Against Temperature Effect for Plantain Stem Sun Dried as Bioadsorbent

Figure 1 illustrates the percentage removal of TPH contaminants in a series of batch operations, examining the temperature's effect on contaminant reduction. Results indicate that setup 1 achieved the highest contaminant reduction, followed by setup 2 and then setup 3. The dried plantain stem fiber demonstrated significant bioadsorbent capacity for treating contaminated water, with maximum removal efficiencies of 63.21% at 45°C for setup 1, 37.83% at 90°C for setup 2, and 55.34% at 60°C for setup 3.

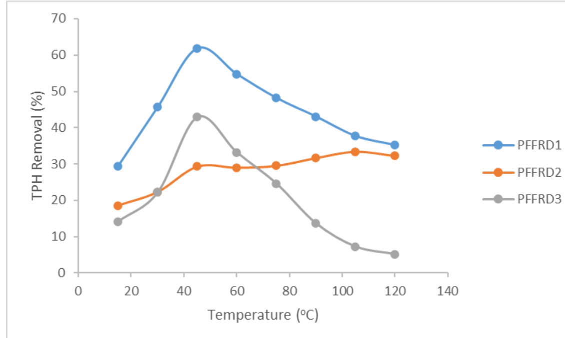

Figure 2: Comparison of Percentage Removal of TPH (Contaminants) against Temperature Effect for Palm Fruit Room Dried as Bioadsorbent

Figure 2 illustrates the comparison of contaminant reduction using room-dried palm fruit fiber as a bioadsorbent in a series of batch operations. The contaminants were passed through various experimental setups, with the removal of TPH monitored throughout the process. The maximum percentage of contaminant reduction achieved was 61.78% at 45°C for the packed bed, 33.46% at 105°C, and 42.95% at 45°C. This research highlights the effectiveness of room-dried palm fruit fiber as a bioadsorbent for treating contaminated water."

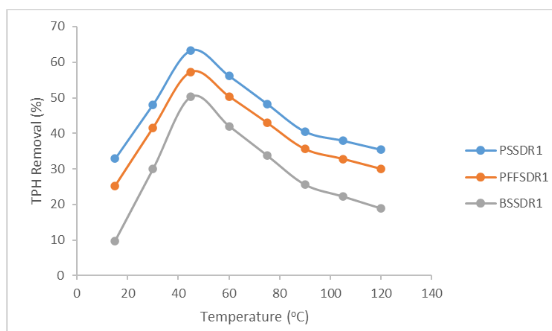

Figure 3: Comparison of the Three Different Bioadsorbents inSun Dried Medium

Figure 3 predicts the comparison of the three different bioadsorbent used such as Plantain Stem fibre, Palm Fruit Fibre and Banana Stem fibre for contaminants removal on the action of temperature effect. Indeed, the comparison reveals the maximum reduction of contaminants and temperature as follow for PSSD is 63.21% (45ºC), 57.32% (45ºC), for PFFSD and 50.23% (45ºC) for BSSD. The PSSD performed better followed by PFFSD and lastly BSSF revealing that

PSFSD performed well compared to PFFSD1 and BSSD1.

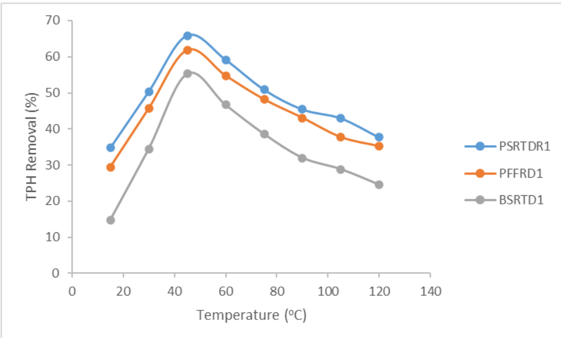

Figure 4: Comparison of the Three Different Bioadsorbent in for Room Dried Medium

Figure 4 illustrates the comparison of TPH (contaminants) removal upon treatment using bioadsorbed of Plantain Stem Room Dried (PSRD), Palm Fruit Fibre Room Dired (PFFRD) and Banana Stem Room Dried (BSRD) on temperature effect. The result reveals maximum contaminant removal by each bioadsorbent in as follow 65.83% (45°C) for PSSD, 61.78% (45°C) for PFFRD and 55.33% (45°C) for BSRD. However, the result demonstrates that plantain stem fibre of room dried is more effective than palm fruit fibre and followed by banana stem fibre all of room dried and at temperature of 45°C.

CONCLUSION

This study demonstrated the potential of agricultural waste materials, specifically sun-dried plantain stem fiber, room-dried palm fruit fiber, and room-dried banana stem fiber, as effective bioadsorbents for the removal of total petroleum hydrocarbons (TPH) from contaminated water. The results indicated that sun-dried plantain stem fiber exhibited the highest removal efficiency, achieving 63.21% at 45°C, followed closely by room-dried palm fruit fiber at 61.78% and room-dried banana stem fiber at 55.33% under similar conditions. These findings highlight the importance of temperature in optimizing contaminant reduction, suggesting that both the type of bioadsorbent and environmental conditions significantly influence adsorption performance. This research supports the use of these natural materials in sustainable water treatment practices and encourages further investigation into their application in real-world scenarios.

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