

**DETERMINATION OF PHYSICO-CHEMICAL PARAMETERS AND  
REMOVAL OF BIS(2-ETHYLHEXYL) PHTHALATE FROM WASTEWATER  
USING *PROSOPIS JULIFLORA* BIOCHAR/CARBON NANOTUBES  
COMPOSITE ADSORBENT**

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**A Thesis Submitted to the Graduate School in Partial Fulfillment of the  
Requirements for the Award of the Degree of Master of Science in Chemistry of  
Chuka University**


**CHUKA UNIVERSITY**

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**DECLARATION AND RECOMMENDATION**

**Declaration**

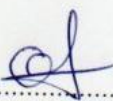
This thesis is my original work and has not been presented, to the best of my knowledge, for examination or award of master's degree in any institution.

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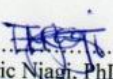
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**Recommendation**

This thesis has been examined, passed and submitted with our approval as the university supervisors.

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## **DEDICATION**

I dedicate this work to my entire family comprising of Mr. and Mrs. Mutua, Sabina, Simon, Asunta, Patrick, Edward, Nathan, Francis and Lydia.

## **ACKNOWLEDGEMENT**

I thank God for giving me strength and wisdom to achieve this dream. I wish to thank my supervisors Prof Joel Gichumbi and Prof Eric Njagi for their guidance throughout the project. My sincere thanks to the Department of Physical Sciences, Chuka University for giving space and facilities to undertake my research. I also thank Mr. Eric, Dr. Ogolla and Madam Juliet for their technical support. I wish to thank my colleagues Jediel Mwenda and Peace Kaviti for their advice during the difficult times.

Lastly, I thank my entire family, my parents Mr. and Mrs. Mutua, my siblings Sabina, Simon, Asunta, Patrick, Edward, Nathan, Francis and Lydia. I will always be grateful for their moral and financial support during my academic journey.

## **ABSTRACT**

Phthalates, such as BEHP, are endocrine-disrupting compounds commonly used as plasticizers. Their presence in wastewater, often from industrial and household effluents,

poses health risks including congenital anomalies, cancer, and chronic toxicity. The high cancer prevalence in Meru County has been linked to toxicants in effluent released into Kathita River, used for domestic purposes and irrigation. This is attributed to the inefficiency of the lagoon wastewater treatment technology in removing chemicals like BEHP. This study evaluates the physico-chemical properties and BEHP levels in wastewater from Meru Sewage Treatment Plant and explores the adsorption of BEHP using a *Prosopis juliflora* biochar/carbon nanotubes composite adsorbent. The temperature, pH, conductivity, turbidity, TDS, TSS, BOD and COD of the wastewater were determined using the standard APHA methods for wastewater, the concentrations of heavy metals using AAS while those of BEHP using HPLC. The following mean values were reported after data analysis: BEHP 0.055mg/L, Cu ND, Pb 0.042mg/L, Cd 0.0019 mg/L, COD 65.99 mg/L, TSS 29.3mg/L, TDS 639.17mg/L, turbidity 117.9FTU, conductivity 1079.9 $\mu$ S, pH 7.3, temperature 26°C and BOD<sub>5</sub> 65.9 mg/L; for dry season. Only pH and COD exceeded WHO limits for wastewater discharge into environment. The wet season parameter mean values were: COD 359.7mg/L, TSS 198.3mg/L, TDS 2094.2mg/L, turbidity 105FTU, conductivity 1244 $\mu$ S, pH 8, temperature 26°C, BEHP 0.0429mg/L, Cu 0.47mg/L, Pb 0.037mg/L, Cd 0.056mg/L and BOD<sub>5</sub> 71.2mg/L. The temperature, TDS, BOD, Cu and Pb met WHO limit while conductivity, turbidity, TSS, COD and Cd exceeded. The composite adsorbent was characterized using FTIR and powder XRD. The dominant functional groups of the composite were C=O, CO<sub>2</sub>, OH-, Si-OH, C=N, MgO, CaCO<sub>3</sub>, and SiO<sub>2</sub>. The composite adsorbent was very efficient in the adsorption of BEHP with up to 96% removal in the samples at determined optimum adsorption parameters of; pH 5, temperature 24 °C, 15 minutes contact time and an adsorbent dose of 200 mg. The isotherm studies showed that the adsorption process was in agreement with the Freundlich isotherms with R<sup>2</sup> value of 0.90469 while the kinetic studies revealed that BEHP adsorption followed pseudo second order model with R<sup>2</sup> of 0.994. It was concluded that the application of biochar/CNTs composite adsorbent for the removal of BEHP from the wastewater is relatively cheaper and eco-friendly and should be applied for treatment of wastewater for irrigation and domestic use to improve water quality and minimize health risks associated with BEHP.