

**DETERMINATION OF PHYSICOCHEMICAL PARAMETERS AND ESTRIOL  
LEVELS IN NYERI WASTE WATER TREATMENT PLANT AND THE  
ADSORPTION OF ESTRIOL USING SUGARCANE BAGASSE-  
MULTIWALLED CARBON NANOTUBE COMPOSITE**

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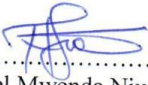
**A Thesis Submitted to the Graduate School in Partial Fulfillment of the  
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Chuka University.**

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## DECLARATION AND RECOMMENDATION

### Declaration

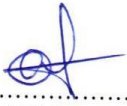
This thesis is my original work and has not been presented for an award of a master's degree in any institution.

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SM11/39805/19


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### Recommendation

This thesis has been examined, passed and submitted with our approval as University Supervisors

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Signature.....  
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## **DEDICATION**

This research work is dedicated to my wife Milka Wanja and my two daughters Adalyn and Briella for the support they have given me throughout my research work. May the Lord bless them all.

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## ABSTRACT

Persistent organic pollutants and endocrine disrupting substances have been found to be highly resistant to degradation. Exposure to these chemicals interferes with normal functioning of endocrine system by causing adverse effects such as cancer and impaired neurodevelopment. Waste water treatment plant mostly concentrate on removal of microorganisms leaving behind micro contaminants such as Estriol. The objective of the study was determination of physicochemical parameters and Estriol levels in Nyeri sewage treatment plant and the removal of Estriol using carbon nanotubes-sugarcane bagasse composite adsorbate. The composite was synthesized by oxidizing Multiwalled carbon nanotube in a ratio 3:1 nitric (V) acid to sulphuric (VI) acid mixture. Multiwalled carbon nanotube were then washed with deionized water and then added to a suspension of sugarcane bagasse powder in a ratio of 100:1, 100:0.5 and 100:0.1. The characterization of the composites was done using Fourier transform infrared spectroscopy and X-ray diffraction techniques. The results showed that turbidity was higher in the dry season at 103.954 NTU compared to 46.5647 NTU in the wet season. Cd was recorded at 0.0168 mg/L during the wet season, which is significantly higher than the 0.0015 mg/L observed in dry season. Copper exhibited a concentration of 0.0833 mg/L in the wet season, which increased substantially to 1.0172 mg/L in the dry season. For Lead, the wet season value was 0.0159 mg/L, while the dry season value of 0.0050 mg/L. Dissolved Oxygen decreased markedly from 7.0617 mg/L in the wet season to 2.2396 mg/L in dry season. These differences in Pb, Cu, and DO levels were confirmed to be statistically significant  $p < 0.05$  based on the Fisher's LSD test with Bonferroni correction for p-value adjustment. Electrical Conductivity increased from 695.782  $\mu\text{S}/\text{cm}$  in the wet season to 1056.104  $\mu\text{S}/\text{cm}$  in the dry season. A t-test was conducted to compare Estriol concentrations between the wet and dry seasons at the Nyeri Water Treatment Plant. The mean Estriol concentration during the dry season was  $1.444 \pm 0.671$  Mg/L while in the wet season it was  $0.982 \pm 0.870$  Mg/L. The mean difference between the two seasons was 0.463, with a weighted standard deviation of 0.777. The optimum conditions obtained from the adsorption of Estriol were; equilibrium time 10 minutes, pH 4, maximum adsorbate concentration adsorbed at 0.1 g of composite 2 was 8 ppm. The composite that gave the best results was composite 2 (100:0.5) with 76.7% adsorption efficiency. The kinetic analysis of estriol best fitted the pseudo first order model with the rate constant for reaction as  $k_1 = -0.1^{-1}$ , with an  $R^2$  value of 1.0. The analysis of adsorption isotherms for Estriol indicated that the Langmuir model provided a good model for fitting adsorption data than the Freundlich model, with a higher  $R^2$  value of 0.5280 compared to 0.439 in Freundlich model. The enthalpy change ( $\Delta H$ ) for the process was calculated to be 26,165.44 J/mol, indicating that the adsorption is endothermic, meaning it absorbs heat from its surroundings. The entropy change ( $\Delta S$ ) was positive 68.85 J/mol-K suggesting an increase in disorder at the solid-liquid interface during adsorption. The Gibbs free energy change ( $\Delta G$ ) was negative at all the tested temperatures showing that the process naturally progresses without the need for external energy input. The findings demonstrated that sugarcane bagasse-carbon nanotube composite is a good low cost and environmentally friendly adsorbent for removal of Estriol from waste water.