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FACULTY OF NATURAL RESOURCES AND ENVIRONMENTAL SCIENCES

DEPARTMENT OF BIOPHYSICAL AND GEOINFORMATION SCIENCES

AN ASSESSMENT OF THE PHYSICO-CHEMICAL WATER QUALITY PARAMETERS OF A SECTION OF RIVER NILE: IMPLICATIONS FOR ALGAL PRODUCTIVITY IN HIGH- RATE ALGAL POND (HRAP)

BY

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DECLARATION

I **TUGONZARUHANGA JOSEPH,** hereby declare that unless otherwise references quoted, the work embodied in this research thesis is solely a result of my own effort and has never been submitted to any other institution of higher learning for the award of the Bachelor's degree.

Signature ……. Date ……

TUGONARUHANGA JOSEPH

APPROVAL

This is to certify that this research thesis has been submitted with my approval as a supervisor

Signature……

Date……

Dr. Sylvie Tebitendwa Muwanga (PhD)

(Supervisor)

DEDICATION

I dedicate my research thesis to my academic research supervisor Dr.Sylvie Tebitendwa Muwanga, my beloved dear mother Ms. Natalie Ruth Atugonza, my family members, my friends especially Mr. Asiimwe Karungi, Mr. Sentongo Oscar, Okirror George William and and Mr. Byaruhanga Valence.

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LIST OF ACRONYMS

µS/cm	microsiemes per centimeter
BOD	Biological Oxygen Demand
COD	Chemical oxygen demand
DO	Dissolved Oxygen
EC	Electrical Conductivity
HRAP	High- Rate Algal Pond
HRTs	Hydraulic residence times
mg/L	Milligrams per litre
NH_4^+-N	Ammonium nitrogen
NO_2^--N	Nitrite nitrogen
NO_3^--N	Nitrate nitrogen
NPK	Nitrogen, Phosphorus and potassium
PAR	Photosynthetically active radiation
SD	Standard deviation
SE	Standard error
SRP	Soluble Reactive Phosphorus
TDS	Total Dissolved Oxygen
TSS	Total suspended Solids
UN	United Nations
WHO	World health organization
WSPs	Waste stabilization ponds

ABSTRACT

River ecosystems are essential in providing many ecosystem services including water for domestic use, irrigation, and aquaculture purpose among others. However, they are continuously degraded due to pollution from anthropogenic activities such as cage fish farming, agriculture, mining, as well as industrial and municipal wastewater discharge to mention but a few. This study therefore aimed to assess the physico-chemical parameters of a section of river Nile in Namasagali and elucidate its suitability for algal productivity in high rate algal pond system (HRAP). The specific objectives were to: i) determine the physico-chemical water quality parameters and ii) evaluate the suitability of water quality for use in HRAP to support algal productivity.

This study was conducted using a pilot scale HRAP system at Namasagali campus, Busitema University. The HRAP system was fed with water from the littoral zone of river Nile, directly pumped into the reserviour tanks. Weekly samples were collected from the HRAP inlet for a period of two months i.e., from 25th January to 29th March, 2023. Physical-chemical variables including water temperature, dissolved oxygen (DO), total dissolved oxygen (TDS), electric conductivity (EC), and pH were measured in-situ using Multiparameter probe model: HANNA I98194. Nutrients particularly Nitrogen and Phosphorus species and Total suspended solids (TSS) were analyzed in the laboratory following APHA (1995) standard guidelines for water and wastewater treatment.

Results showed that physicochemical and nutrients concentrations were highly variable during the sampling period and these were: temperature: 23.43-29.59 ^{o}C (26.59±0.58^{o}C), DO: 1.02-3.72 (2.67±0.23mg/L), pH: 6.88-8.63 (8.21±0.17), EC: 97-126.33 µS/cm (102.20±2.71µS/cm), TDS: 49-63.67mg/L (51.30±1.38 mg/L), NO_2^-N: 0.18-0.25 mg/L (0.21±0.01mg/L), NO_3^--N: 0.18-0.65 mg/L (0.33±0.04 mg/L), NH_4^+-N: 0.17-0.35 mg/L (0.23±0.02 mg/L), SRP: 9.83-16.15 mg/L (11.08±0.60 mg/L) and TSS: 6.67-30.00 mg/L (13.67±2.25 mg/L).

Further analysis revealed that the most critical parameters were within the range required to support algal productivity in a HRAP system.

In conclusion, the study revealed that the water quality from river Nile in Namasagali area is suitable for use to support algal productivity in a HRAP system. However, it is recommended that further studies should investigate the COD river water quality and algal productivity in a HRAP system before full-scale implementation.

CHAPTER ONE

INTRODUCTION

1.1 **Background**

High-Rate algal ponds (HRAPs) are sustainable alternative low-cost wastewater treatment technology (Buchanan *et al.*, 2018). According to Mahmood *et al.*,(2013), and Young *et al.*,(2017), HRAPs are open, shallow (0.2 to 0.4m), paddle wheel mixed ponds (at linear velocity of 1.15 to 0.3 m/s) in which like conventional wastewater stabilization ponds (WSP), wastewater treatment is achieved through a symbiotic association between algae and bacteria powered by sunlight as a source of energy to remove pollutants from wastewater. Microalgae uptakes nutrients especially Nitrogen and Phosphorus from wastewater and via the process of photosynthesis, it supplies oxygen to bacteria for use to mineralize organic matter (Benemann *et al.*, 2013; Chisti, 2013; Thomas *et al.*, 2016). In turn, microalgae utilize carbon dioxide produced by bacteria during respiration for growth (Van Den Hende *et al.*, 2016; Khetkorn *et al.*, 2017; Arias *et al.*, 2018) as shown in the figure below.

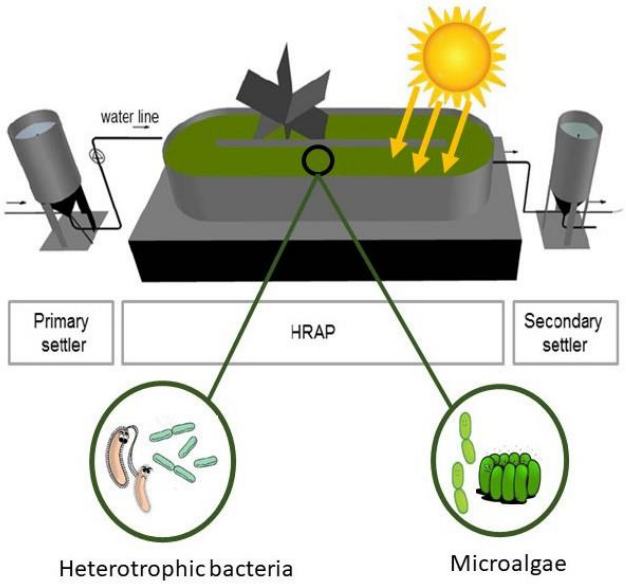

Figure 1. 1. A picture showing a symbiotic relationship between bacteria and algae during wastewater treatment in a HRAP system (Benemann *et al.*, 2013).

These biochemical and physical processes that occur in a more natural environment rather than tank reactors result in a system that is passive, consumes less energy and requires less

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