Productions of high quality wastewater final effluents remain a challenge in the Eastern Cape Province of South Africa

by

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A dissertation submitted in fulfillment of the requirements for the degree of

MASTERS OF SCIENCE

(MICROBIOLOGY)

In the Faculty of Science and Agriculture at the University of Fort Hare

2012

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DECLARATION

I, the undersigned, declare that this dissertation submitted to the University of Fort Hare for the degree of Masters of Science in Microbiology in the Faculty of Science and Agriculture, School of Biological and Environmental Sciences, and the work contained herein is my original work with exception of the citations and that this work has not been submitted at any other university, either in part or in its entirety, for the award of any degree.

Name: _____

Signature: _____

Date: _____

ACKNOWLEDGEMENTS

There is absolutely nothing you can do successfully on your own without God, so to Him I give the praise and glory. He has provided me with mentors, family and friends to whom I can lean on and cry to in times of need.

I give special words of gratitude to my supervisor, mentor and parent, Prof. Anthony I. Okoh for the guidance, training and academic grooming he has given to me ever since I met him four years back. He has been good to me, made me believe in myself, and he has entrusted his resources towards me fulfilling my dreams. I can stand at the top of the mountain and loudly say that everything I know and the respect I have for myself and others and the person that I am today won't have surfaced if he did not believe in me and my capabilities. So to you Prof. I will forever be gratefully to you.

It goes without saying that the patience and the tolerance my mother gave me despite my carelessness and lack of focus has landed me where I am today. She never gave up on me against all odds, and she used all her resources to make sure that I become a better person through education and that at the end I'll be indispensable in helping out my family more especially my siblings to achieve their own goals. Of course all my extended family members mustn't feel offended that I made no mention of them in this work, you all played a role in my upbringing and that you will all be a great part of my life.

I would also like to thank all members of Applied and Environmental Microbiology Research Group (AEMREG), past and present, for their continued support since ever joining the group.

They have taught me so much; most importantly that collective effort works wonders despite of your level of education. Team work really does build oneself, and keeping of brotherly and sisterly spirits.

I would like to acknowledge the financial support of the Water Research Council (WRC) without which this research work would not have been a success. I also like to thank the University of Fort Hare for affording me the chance to use their facilities to pursue my studies over the years till to date. Also I would like to thank the Govan Mbeki Research and Development Center (GMRDC) for paying out my tuition fees.

DEDICATION

I Dedicate this Dissertation to:

My parents Ms T. S. Gusha and Mr. M. L. Hani

My late daughter Limpho Nonginzi

My son Solulele Vena

My brothers and sisters Sonwabo Gusha, Anga Gusha, Nosiviwe Gusha and Sanelisiwe Hani

My niece and nephew Lithemba and Ahlume Gusha

My grandparents Mr. Sizakele and Nosensi Gusha

And All my aunts and uncles

Your support means a lot to me and is priceless more especially the birth of my son gave me something to live and look up to.

LIST OF ABBREVIATIONS

µg/ml	-	Microgram per Milliliter
µl	-	Microliter
A/E	-	Attaching-Effacing
AAF	-	Aggregative Adherence Fimbriae
aEPEC	-	Atypical Enteropathogenic *Escherichia Coli*
Afas	-	Afimbrial adhesive sheaths
AHC	-	Acute Hemorrhagic Conjunctivitis
AK	-	Amikacin
$AlCl_3$	-	Aluminum chloride
AP	-	Ampicillin
APHA	-	American Public Health Association
API	-	Analytical Profile Index
BFP	-	Bundle-Forming Pili
BOD	-	Biological Oxygen Demand
C	-	Chloramphenicol

CAR	-	Coxsackievirus-Adenovirus Receptor
CCA	-	Chromocult Coliform Agar
CFU	-	Colony Forming Units
CIP	-	Ciprofloxacin
CLSI	-	Clinical Laboratory Standards Institute
COD	-	Chemical Oxygen Demand
CPE	-	Cytopathogenic Effect
CTX	-	Cefotaxime
CVA	-	Coxsackievirus A
CVB	-	Coxsackievirus B
CVB3	-	coxsackievirus B3
CXM	-	Cefuroxime
DA	-	Diffuse Adherence
DAEC	-	Diffusely Adherent *Escherichia coli*
DO	-	Dissolved Oxygen
DWAF	-	Department of Water Affairs and Forestry

DXT	-	Doxycycline
E	-	Erythromycin
E. coli	-	*Escherichia coli*
E. faecalis	-	*Enterococcus faecalis*
E. faecium	-	*Enterococcus faecium*
EAEC	-	Enteroaggregative *Escherichia coli*
EHEC	-	Enterohemorrhagic *Escherichia coli*
EIEC	-	Enteroinvasive *Escherichia coli*
EPEC	-	Enteropathogenic *Escherichia coli*
ESA	-	Enterococcus Selective Agar
ETEC	-	Enterotoxigenic *Escherichia coli*
EVs	-	Enteric Viruses
FC feacal	-	Feacal Coliforms
FDA	-	Food and Drug Administration
FE	-	Final Effluent
FIB	-	Feacal Indicator Bacteria

GM	-	Gentamycin
H_2SO_4	-	Sulphuric acid
HAdVs	-	Human Adenoviruses
HAV	-	Hepatitis A virus
HEV	-	Hepatitis E virus
HFM	-	Hand, Foot, Mouth
I	-	Intermediate
ICC/qRT-PCR-		Integrated Cell Culture Real-Rime RT-PCR
IMI	-	Imipenem
K	-	Kanamycin
LEE	-	Locus of Enterocyte Effacement
LT	-	Heat-Labile Toxin
MEM	-	Meropenem
MH	-	Mueller-Hinton agar
MIC	-	Minimal Inhibitory Concentration
mm	-	Millimeter

mM	-	Millimole
mRNA	-	Messenger RNA
MST	-	Microbial Source Tracking
NA	-	Nutrient Agar
NaOH	-	Sodium Hydroxide
NB	-	Nutrient Broth
NO_2^{-1}	-	Nitrite
NO_3^{-1}	-	Nitrate
NOR	-	Norfloxacin
NV	-	Norovirus
^oC	-	Degree Celsius
ORF	-	Open Reading Frame
P	-	Phosphorus
PCR	-	Polymerase Chain Reaction
PUC	-	Peri-Urban Community
EAF	-	Adherence Factor Plasmid

R	-	Resistant
RC	-	Rural Community
RGD	-	Arginine-Glycine-Aspartic Acid
RT-PCR	-	Reverse Transcriptase-PCR
RV	-	Rotavirus
S	-	Streptomycin
S	-	Susceptible
T	-	Tetracycline
TC	-	Total Coliforms
tEPEC	-	Typical Enteropathogenic *Escherichia Coli*
TTSS	-	Type III secretion system
UN	-	United Nations
USEPA	-	United States Environmental Protection Agency
UV	-	Ultraviolet
WHO	-	World Health Organization
WWTPs	-	Wastewater Treatment Plants

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ABSTRACT

Water is an indispensible and yet a difficult resource to be renewed, thus water scarcity has become one of the major challenges faced worldwide, with the Southern regions of Africa being the most impacted and affected, especially the Eastern Cape Province of South Africa where rural communities depend on receiving waterbodies that are often negatively impacted by wastewater final effluents. This present study was conducted between August and December 2010 to assess the physicochemical and microbial qualities of the final effluents of peri-urban and rural communities based wastewater treatment plants in the Eastern Cape Province. The physicochemical parameters were determined on site and in the laboratory, while bacteriological qualities were determined using culture based techniques. The virological qualities were determined by molecular methods using reverse transcriptase polymerase chain reaction for the target RNA virus and the conventional polymerase chain reaction for the target DNA virus. For both wastewater treatment plants, the physicochemical parameters ranged as follows: chemical oxygen demand (5.95-45 mg/L); total dissolved solids (114.5-187.0 mg/L); salinity (0.12-0.20 psu); temperature (14.2-25.7^{o}C); pH (6.0-7.6); nitrate and nitrites (1.55-6.7 mg/L and 0.023-1.15 mg/L respectively); biological oxygen demand (3.5-7.8 mg/L); turbidity (1.49-6.98 NTU); and chlorine residual (0-2.97 mg/L). Feacal indicator bacteria counts ranged as follows: feacal coliforms (0-1.25×10^{4} cfu/100 ml); total coliforms (0-3.95×10^{4} cfu/100 ml); and enterococci (0-5.0×10^{3} cfu/100 ml).

Seventy five percent of the rural community based plant and 80% of the peri-urban community based plant were positive for coxsackie A virus, while hepatitis A virus was detected in all the rural community based plant 80% of the peri-urban community based plant. This study suggests the need for intervention by appropriate regulatory agencies to ensure regular monitoring of the qualities of final effluents of wastewater treatment facilities in the Eastern Cape Province and ensure compliance to established guidelines.