

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

by

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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: _____

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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.

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DEDICATION

I Dedicate this Dissertation to:

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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

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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 <i>Escherichia Coli</i>
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 <i>Escherichia coli</i>
DO	-	Dissolved Oxygen
DWAF	-	Department of Water Affairs and Forestry

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

GM	-	Gentamycin
H ₂ SO 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-Time 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
°C	-	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 <i>Escherichia Coli</i>
TTSS	-	Type III secretion system
UN	-	United Nations
USEPA	-	United States Environmental Protection Agency
UV	-	Ultraviolet
WHO	-	World Health Organization
WWTPs	-	Wastewater Treatment Plants

LIST OF FIGURES

Figure 3.1: The Eastern Cape Province	36
Figure 3.2: Schematic representation of analysis of water samples for the detection of enteric viruses	47

LIST OF TABLES

Table 3.1: Zone diameter interpretative standards and equivalent minimal inhibitory concentration (MIC) breakpoints for enterobacteriaceae	44
Table 3.2: Recommended reaction components for reverse transcription of viral RNA	48
Table 3.3: The recommended thermal cycling conditions for coxsackie A virus detection	49
Table 3.4: The recommended thermal cycling conditions for hepatitis A virus detection	50
Table 3.5: Oligonucleotide sequences used for the detection of hepatitis A virus and coxsackie A virus	50
Table 4.1: Physicochemical qualities of the final effluents of the rural community (RC) and the peri-urban community (PUC) based wastewater treatment plants	54
Table 4.2: Correlation of the physicochemical and microbial qualities for the PUC based wastewater treatment plant	55
Table 4.3: Correlation of the physicochemical and microbial qualities for the RC based wastewater treatment plant	56
Table 4.4: Faecal indicator bacteria counts of the wastewater final effluents from both plants	57
Table 4.5: Antibigram of <i>E. coli</i> isolates from wastewater final effluents	59
Table 4.6: Prevalence of hepatitis A virus and coxsackie A virus in wastewater final effluents from both plants	60

TABLE OF CONTENTS

Page number

Declaration	i
Acknowledgements	ii
Dedication	iv
List of Abbreviations	v
List of Figures	xi
List of Tables	xii
Table of Contents	xiii
Abstract	xviii
CHAPTER 1 INTRODUCTION	1
1.1 General Introduction	1
1.2 Justification of this Research	3
1.3 Aim and Objectives for this Study	5
CHAPTER 2 LITERATURE REVIEW	6
2.1 Wastewater	6
2.1.1 Wastewater Treatment	7
2.1.1.1 Primary treatment	7
2.1.1.2 Secondary treatment	8
2.1.1.3 Tertiary treatment	9
2.2 Faecal Indicator Bacteria (FIB)	9
2.2.1 Total coliforms	10
2.2.2 Faecal coliforms	11
2.2.3 Enterococci	11
2.3 <i>Escherichia coli</i> (<i>E. coli</i>)	12

2.3.1 Enterotoxigenic <i>E. coli</i> (ETEC)	14
2.3.2 Enterohemorrhagic <i>E. coli</i> (EHEC)	15
2.3.3 Enteropathogenic <i>E. coli</i> (EPEC)	15
2.3.4 Enteroinvasive <i>E. coli</i> (EIEC)	16
2.3.5 Enteroaggregative <i>E. coli</i> (EAEC)	17
2.3.6 Diffusely adherent <i>E. coli</i> (DAEC)	18
2.4 Enteric Viruses (EVs)	19
2.4.1 Enteroviruses	20
2.4.2 Noroviruses (NVs)	22
2.4.3 Adenoviruses	23
2.4.4 Rotaviruses	24
2.5 Hepatitis A and E Viruses	24
2.5.1 Epidemiological background	25
2.5.2 Pathogenesis	26
2.5.3 Clinical symptoms and manifestations	26
2.5.4 Clinical diagnosis	27

2.5.5 Treatment, prevention and control	28
2.6 Coxsackieviruses	28
2.6.1 Epidemiology	29
2.6.2 Pathogenesis	30
2.6.3 Clinical symptoms and manifestations	31
2.6.4 Clinical diagnosis	31
2.6.5 Treatment, prevention and control	31
2.7 Detection Methods of Viruses in Environmental Water Samples	32
2.7.1 Cell culture method	33
2.7.2 Polymerase chain reaction (PCR) methods	33
CHAPTER 3 METHODOLOGY	35
3.1 Study Area	35
3.2 Sampling Sites Description	37
3.3 Sample Collection	38
3.4 Physicochemical Analysis	38
3.4.1 Biological oxygen demand (BOD) analysis	39

3.4.2 Chemical oxygen demand (COD) analysis	39
3.4.3 Determination of nitrates	40
3.4.3 Determination of nitrites	40
3.4.3 Determination of phosphates	41
3.5 Microbiological Analysis	41
3.5.1 Isolation and presumptive identification of <i>E.coli</i>	42
3.5.2 Confirmative identification of <i>E. coli</i> isolates	42
3.5.3 Antimicrobial susceptibility test	43
3. 6 Detection of Hepatitis A virus and Coxsackie A virus	45
3.6.1 The adsorption-elution method	45
3.6.2 RNA extraction	46
3.6.3 Reverse transcription	48
3.6.4 PCR detection of hepatitis A virus and coxsackie A virus	49
3.7 Agarose gel electrophoresis	50
3.8 Statistical analysis	51
CHAPETR 4 RESULTS	52
4.1 Physicochemical analyses	52
4.2 Microbiological analyses for indicator bacteria	53
4.3 Correlation data for all tested parameters	57

4.4 Identification and antibiogram of <i>E. coli</i> isolates	58
4.5 Detection of hepatitis A virus and coxsackie A virus	59
CHAPTER 5 DISCUSSION, CONCLUSION AND FUTURE DIRECTIONS	61
5.1 Discussion	61
5.2 Conclusion and future directions	69
REFERENCES	71

ABSTRACT

Water is an indispensable 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°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). Faecal indicator bacteria counts ranged as follows: faecal coliforms ($0-1.25 \times 10^4$ cfu/100 ml); total coliforms ($0-3.95 \times 10^4$ cfu/100 ml); and enterococci ($0-5.0 \times 10^3$ 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.