IAA Journal of Biological Sciences 8(1):40-68, 2022. ISSN: 2636-7254

The physicochemical parameters, antibiogram and antibiotic resistance index (MARI) of the soil samples contaminated with urine around lecture theatres in four campuses of Ebonyi State University, Abakaliki.

[1]Orji J.O., [1]Nwankwo C.E., [2]Akindele K.I., [1]Uwa C.I. and [3]Edemekong C. I.
[1]Department of Microbiology Ebonyi State University Abakaliki.
[2]Department of Microbiology Alex Ekwueme Federal University Ndufu-Alike Ikwo.
[3]Department of Biotechnology, Federal College of Dental Technology and Therapy Trans Ekulu Enugu.

ABSTRACT

Transmission of pathogenic bacteria is possible through contact with contaminated objects or surfaces. Microorganisms from public soil contaminated with urine have potential to cause diseases like bacteremia, urinary tract infections (UTIs), pneumonia, bloodstream infections, wound infections, meningitis, tissue necrosis, musculoskeletal infections, especially the immuno-suppressed individuals either as primary or opportunistic pathogens. The aim of this reearch was to determine the physicochemical parameters, antibiogram and antibiotic resistance index (MARI) of the soil samples contaminated with urine around lecture theatres in four campuses of Ebonyi State University, Abakaliki. The results of exchangeable cations soil samples contaminated with urine (LA) and the control soil samples (CA). It reveals that sodium (Na^+) had the lowest mean± standard deviation values of 0.26±0.02 in the soil samples contaminated with urine (LA) when compared with the control soil samples (CA) with the highest mean value of 0.30±0.02. Potassium (K^+) showed the highest in the soil contaminated with urine (LA) with the mean value of 0.57±0.41 when compared with the control soilsample (CA) with the mean± standard deviation value of 0.18±0.02. Antibiotic susceptibility and resistance profile of *Staphylococcus* speciesisolated from soil samples contaminated with urine revealed that the isolates weretotally 9(100%) susceptible to cefoxitin and least susceptibility of 2(22.2%) to cefotaxime but highest resistant of 7(77.8%) to cefotaxime while least resistantwere observed in gentamycin with 2(22.2%) out of nine (9) isolates. Antibiotic susceptibility and resistance profile of *Enterobacter* species isolated from soil samples contaminated with urine revealed that the isolates were highly susceptible to gentamycin, ciprofloxacin and cefotaxime 5(83.3%) each, and amikacin 4(66.7%) but totally resistant of 6(100%) to oxacillin, cefoxitin, clindamycin, meropenem and mupirocin and least resistant of 1(12.5%) to gentamycin, ciprofloxacin and cefotaxime out of six (6) isolates. Antibiotic susceptibility and resistance profile of *Streptococcus* species isolated from soil samples contaminated with urine. The isolates showed were totally susceptible of 5(100%) to cefotaxime and lowest susceptibility of 1(20%) to meropenem and mupirocin but highest resistant of 5(100%) to ceftazidime and least resistant of 1(20%) to ciprofloxacin each out of five (5) isolates. The Result of multiple antibiotics resistance index (MARI) of bacteria isolated from soil samples contaminated with urine around lecture theatres in Ebonyi State University, Abakaliki. Results obtained revealed that among the bacteria isolated from soil samples contaminated with urine around lecture theatres in four campuses of Ebonyi State University, Abakaliki; *Enterobacter* species had the highest average MARI value of 0.68, followed by *Pseudomonas* species with the average MARI value of 0.66 while *Staphylococcus* species showed the lowest average MARI value of 0.51. The results of this study revealed that the soils contaminated with urine increases the population of most pathogenic bacteria as only eight (8) bacteria was isolated from the 24 samples collected for this study. The pH of soil samples contaminated with urine was acidic due to urine concentration whereas the pH of

the control soil samples was slightly acidic or neutral. There was significant increase in the physicochemical parameters of soil contaminated with urine than the control in conductivity, nitrate, phosphate and sulphate whereas the exchangeable cations (Na^+, K^+, Ca^+ and Mg^+) had significant variation in the soil contaminated with urine and the control soil. The bacterial isolates were generally susceptible to gentamycin and ciprofloxacin but totally resistant to ceftazidime(100%) except *Staphylococcus* spp. The result of MARI showed that out of the Gram-positive bacteria isolated, *Staphylococcus* species had the lowest average MARI value of (0.51) while out of the Gram-negative bacteria isolated *Enterobacter* species had the highest average MARI value of (0.68).
Keywords; Physicochemical, antibiogram, antibiotic resistance index, soil samples

INTRODUCTION

Soil is the particulate material of the outer rust of the earth formed from continuous weathering of the underlying rocks [1,2].The soil is the most important constituent to fulfillment of all the basic needs of human beings [3,4]. Soil is an important component of our farming.It is also a mixture of organic matter, minerals, gases, liquids, and organisms that together support life. It is also one of the most important natural resources of a country [5,6,7]. Earth's body of soil is the pedosphere, which has four important functions: it is a medium for plant growth; it is a means of water storage, supply and purification; it is a modifier of Earth's atmosphere; it is a habitat for organisms; all of which, in turn, modify the soil [8]. Soil consists of a solid phase of minerals and organic matter (the soil matrix), as well as a porous phase that holds gases (the soil atmosphere) and water [9]. Public urinal soils may become major factors in the spread of infection especially when adequate sanitary facilities are not available. Microorganisms from public soil contaminated with urine have potential to cause diseases like bacteremia, urinary tract infections (UTIs), pneumonia, bloodstream infections, wound infections, meningitis, tissue necrosis, musculoskeletal infections, especially the immuno-suppressed individuals either as primary or opportunistic pathogens [10,11,12]. Transmission of pathogenic bacteria is possible through contact with contaminated objects and/or surfaces [13]. Again, transmission via inhalation (breath- in) of contaminated droplets and/or aerosols may also be possible [14].

Aim of the Study

The aim of this reearch was to determine the physicochemical parameters, antibiogram and antibiotic resistance index (MARI) of the soil samples contaminated with urine around lecture theatres in four campuses of Ebonyi State University, Abakaliki.

MATERIALS AND METHODS

Study area

The samples were collected in four (4) Campuses comprising College of Health Science, College of Agricultural Science, Ishieke Campus and Permanent Site in Ebonyi State University, Abakaliki. Ebonyi state was created in 1st October, 1996, from the former Abia and Enugu States with Abakaliki as its capital. College of Agricultural Science is under Abakaliki Local Government with the population of about 198,100 while College of Health Science, Ishieke and Perm Site are under Ebonyi Local Government with the population of about 168,300 according to National Population Commission in 2006 Census and their occupation is mainly farming, all in Ebonyi State. Ebonyi State rest within longitude 7.30' and 8.30'E and latitude 5.40' and 6.45'N. Abakaliki is located in the lower belt of Nigeria and situated on the high land with tropical rainforest as its vegetation. The annual rainfall is about 200mm and 120mm with a humidity range from 60-65%. The

annual temperature ranges from 15^{0}C – 29^{0}C.

Figure 1:Map of Abakaliki showing the study area [8].

Collection of samples

The total of 24 soil samples were aseptically collected in the dry season between January to February, 2018 when school is in session, from four (4) campuses of Ebonyi State University, Abakaliki. Three (3) soil samples were randomly collected and mixed in each of the units using auger around lecture theatres noted for regular urine discharge, while 100 meters away (not used for urine discharge) were used as a control (between 5-6 inches and 5-10cm) respectively. The samples collection points were College of Health Science (CO^2 Hall, Faculty of Medicine (pre-clinic), Gross Anatomy Laboratory;College of Agricultural Science (Faculty of Agriculture and Natural Resources Management, Faculty of Law, Pre-Degree Hall), Ishieke Campus (Education Hall, Management Hall 2,Management Hall 3), and Permanent Site (Faculty of Social Science and Humanities Block A, Faculty of Social Science and Humanities Block B, Faculty of Social Science and Humanities Block C) (LA). Samples of soil contaminated with urine (LA) and control soil samples (CA) were collected using sterilesample bottles and were labeled appropriately and then transported to Applied Microbiology Laboratory unit of Ebonyi State University, Abakaliki for immediate bacteriological analysis within two (2) hours of samples collection.

Sterilization of materials and other glassware

Most of the materials used were thoroughly washed with detergent, rinsed and then allowed to dry. The glasswares were then wrapped with aluminum foil and sterilized in a hot air oven at 160^{0}C for 60 minutes before use. The distilled water used for serial dilutions were autoclaved at 121^{0}C for 15 minutes. The working area was swabbed with 70% alcohol before and after use.

Media preparation

All the media used were aseptically prepared according to the manufacturer's instruction.

Nutrient agar (NA)

Exactly 9.0g of nutrient agar powder was weighed and transferred into 320ml of distilled water in a 500ml conical flask. The content of the flask was rotated for proper dissolution of the hydrated media. The mouth of the flask was covered with cotton wool, wrapped firmly with aluminum foil and then autoclaved at 121^{0}C for 15minutes. It was allowed to cool at 45^{0}C before 20ml was dispensed aseptically in petri dishes. The media was allowed to gel on the petri dishes [14].

MacConkey agar (MA)

Exactly 21.3g of MacConkey agar was weighed using weighing balance and transferred into 400ml of distilled water. This was allowed to dissolve fully by gentle shaking. The media was sterilized by autoclaving at 121^{0}Cfor 15 minutes. After which it was allowed to cool at 50-55^{0}C but not solidified. It was then mixed well before pouring and dispensed aseptically in 15-20ml amounts in sterile petri dishes [15].

Mannitol salt agar (MSA)

Exactly 39.96g of Mannitol salt agar was weighed using weighing balance and transferred into 360ml of distilled water. The media was sterilized by autoclaving at 121^{0}Cfor 15 minutes. After which it was allowed to cool at 50-55^{0}C but not solidified. It was then mixed well before pouring and dispense aseptically for 15-20ml amounts in sterile petri dishes [16].

Cysteine lactose electrolyte deficiency (CLED)

Exactly 13.1g of Cysteine lactose electrolyte deficiency was weighed using weighing balance and transferred into 360ml of distilled water. The media was sterilized by autoclaving at 121^{0}Cfor 15 minutes. After which it was allowed to cool at 50-55^{0}C but not solidified. It was then mixed well before pouring and dispensed aseptically in 15-20ml amounts in sterile petri dishes [17].

Peptone water (PW)

Exactly 4.2g of peptone water powder was suspended into 180ml of distilled water contained in a sterile beaker. It was shaken to enhance homogeneity after which 5ml was dispensed into sterile test tubes and covered with cotton wool. The neck of the conical flask was tied firmly with a masking tape. It was sterilized by autoclaving at 121^{0}C for 15 minutes and allowed to cool at 45^{0}C.

Muller-Hinton agar (MHA)

Exactly7.6g of Muller-Hinton agar was suspended into 200ml of distilled water in 500ml of beaker and then shaked gently to mix properly. The beaker was covered with cotton wool and aluminum foil with masking tape and then autoclaved at the temperature of 121^{0}C for 15 minutes and allowed to cool at 45^{0}C before pouring into petri dishes gently and allowed to gel.

Sample preparation and isolation of bacteria

Soil samples were subjected to bacteriological analysis using the method of [18]. Pour plating was done using Nutrient agar. Techniques employed to reduce load and prevent overcrowding of petri dish plates was the serial dilution for bacteria. One gram (1g) of each soil sample contaminated with urine (LA) and control soil samples (CA) were diluted each in 9ml of sterile distilled water in test-tubes, followed by 10 fold serial dilution. One-tenth of a milliliter (1/10th ml) of the 5th fold dilution factors were plated out in duplicates on nutrient agar of 0.5ml using sterile syringe after preliminary study was carried out. The plates were incubated at 37^{0}C for

24hours. Bacterial counts were recorded in colony forming units per ml (CFU/ml) usingcolonycounter.

Determination of the Physicochemical Parameters of Soil Samples

A number of physicochemical parameters of soil contaminated with urine (LA) and control soil samples (CA) were determined using standard procedures. At the laboratory, 2mm and 0.5mm mesh-size sieves were used to sieve the soil samples from different sites. The sieved soil samples were analyzed for texture, Soil type, Colour, pH, conductivity, nitrate, Ammonium, phosphate, Sulphate.

(i) **Texture:** Soil texture was determined by rubbing few quantities of each samples in-between finger tips.

(ii) **Soil Type:** Soil type was determined by physical observation.

(iii) **Colour**: The colour of the various soil samples was determined in comparison with munsel colour chart.

(iv) **pH:** The pH of the soil samples was determined by mixing 5g of soil with 20ml of distilled water in a 50ml beaker. The mixture was stirred with a white rod stirrer for 5 minutes. The pH values were measured using Jenway model 3015 pH meter.

(v) **Conductivity:**The conductivity of the soil samples was determined by drying and difference in weight method using Hach conductivity meter (Model CO150). Ten (10) gram of soil samples was measured into a 100ml of beaker. The 50ml of distilled water was poured into the beaker containing 10g of soil samples and then stirred gently for 10 seconds. The mixture was allowed to settle down for 1-2hours. After that, the tip of the calibrated electrical conductivity (EC) meter was immersed into the soil phase of the mixture. It was allowed to stabilize before taken the reading and then recording the EC1:5vol of the unfiltered supernatant [19].

(vi) **Nitrate in Soil**: The nitrate in soil was determined by spectrophotometric method. The extracting solution was first prepared by dissolving 100g of sodium acetate in 500ml 0f distilled water and 30ml of 99.6% acetic acid were added. The mixture was diluted with 1litre of water. Exactly 5g of soil sample were put into a beaker and 0.25g of activated carbon with 20ml of extracting solution was added. The mixture was shaked for 1minute for proper mixture and then filtered to remove the particles. Then 1ml aliquot of the soil extract was transferred into a vial. 0.5 ml of brucine reagent and 2ml of sulphuric acid were added. The solution were mixed for 30 seconds and then allowed to stand for 5minutes. The solution was mixed again and 2ml of distilled water were added and then mixed for another 30 seconds. The tube was allowed to stand for 5 minutes and the transmittance was measured at 470nm using electro photometer [20].

(vii) **Sulphate in Soil:** Twenty gram (20g) of soil sample without particles was measured into a beaker and dissolved with 20ml of distilled water. The mixture was properly stirred with magnetic stirrer for 10-15minutes. Ten (10ml) millitre of sample aliquot was pipetted into a 25ml of volumetric flask and distilled water was added to bring the volume to 20ml. Then 1ml of gelatin barium chloride reagent (GBCR) was added and the content mixed together and allowed to stand for 30minutes. The transmittance and optical density was measured using electro photometer at 400-500nm [21].

(viii) Phosphorous in Soil: The phosphate of the soil samples was determined by removing the large particles and foreign materials from the soil samples.Five (5g) of soil was put into aclean and dry plastic bottle.Add exactly 50 ml of 2.5% acetic acid solution was added into the bottle and the solution mixed for two minutes manually and kept for about three hours until the supernatant separates.Then 5 ml of supernatant was put into a transparent glass bottle.Exactly 5 ml of color developing reagent was added before adding 5 ml of distilled water. The solution was mixed and allowed to stand for about 15 minutes to develop the blue colour.The blue colour intensity was measured using the coloure chart provided [22].

(ix)Determination of Exchangeable Cat ions in Soil: The cations exchange capacity (CEC) of a soil is a measure of the quantity of negatively charged sites on soil surfaces that can retain positively charged ions (cations). The soil samples were first extracted using ammonium acetate solution. This was done by weighing 5g of sieved air-dried samples and adding 30ml of the extracted solution in a tube and was shaked on a mechanical shaker for two hours. They were then centrifuged for 5 minutes and the supernatant was carefully decanted into a 100ml volumetric flask. This was then made up to the mark with the extracting solution. The exchangeable cations (Sodium (Na^+), potassium (K^+), Calcium (Ca^{2+}), and magnesium (Mg^{2+}) of the extract were determined using Unicam atomic absorption spectrophotometer (Model 969) [23].

Preparation of MacFarland turbidity standard

Turbidity standard equivalent of 0.5 MacFarland was prepared by adding 1ml of concentrated tetraoxosulphate (vi) acid to 99ml of distilled water, and dissolved 0.5g of dehydrated barium chloride ($Bacl_2.2H_20$) in 50ml of distilled water in a separate reaction flask respectively. Barium chloride solution of 0.6ml was added to 99.4ml of tetraoxosulphate (vi) acid solution in a separate test tube, and the reaction mixture were mixed well to 0.5 MacFarland turbidity standard. Small portion of the turbid solutions was transferred to a capped test tube similar to the tube used for preparing the test organism and stored at a room temperature [24].The tested organisms were standardized individually before use to 0.5 MacFarland turbidity standards.

Antibiotic susceptibility test

This test was carried out to know the susceptibility of the organism to antibiotics. Antibiotic susceptibility testing on the bacterial isolates using disc diffusion method technique as described by Kirby Bauer according to the guidelines of National Committee for Clinical Laboratory Standards (NCCLS, 2002) with the following antibiotics: gentamycin (CN), ciprofloxacin (CIP), amikacin (AK), clindamycin (CM), meropenem (MEM), mupirocin (MUP), oxacillin (OX), cefoxitin (FOX) , cefotaxime (CT), ceftazidime (CAZ),on the bacterial isolates from urine contaminated soil and control soil samples around lecture theatres in Ebonyi state university, Abakaliki. The bacterial inocula were prepared by suspending the colonies of the organism from an overnight culture on nutrient broth and adjusted the turbidity of the suspension to 0.5 McFarland standard using a sterile swab stick, standardized isolates were streaked on a sterile Muller-Hinton agar plates and allowed for pre-diffusion. The above-mentioned antibiotics were placed aseptically on the plates. The plates were incubated at 37^0C for 24 hours, and the inhibition zones were recorded in diameter using a calibrated meter rule

Determination of Multiple Antibiotic Resistance Index (MARI)

Multipleantibiotics resistance index (MARI) was determined to know the resistance level of the isolates. The method described by [7] was used.

MARI = a/b is the formula used.

Where

a = number of antibiotics to which th e test isolates showed resistance.

b = total number of antibiotics to which the test isolates has been evaluated for susceptibility.

Statistical Analysis

The results obtained in this study were subjected to standard statistical analysis by the use of correlation analysis, standard mean deviation, Pearson's chi-square, ANOVA and in percentage. This was used to determine the significance of the results at $p<0.05$.

RESULTS

Table 1: Physical Parameters and pH of Soil Samples Contaminated with Urine and Control Around Lecture Theatres in Ebonyi State University, Abakaliki.

Campus	Texture of Soil Samples		Type of Soil Samples		Colour of Soil Samples		PH	
	LA	CA	LA	CA	LA	CA	LA	CA
	Coarse	Coarse	Loamy	Loamy	Dark-brown	Dark-brown	4.25	7.00
CHS	Coarse	Coarse	Loamy	Loamy	Green	Brown	4.01	7.01
	Coarse	Coarse	Loamy	Loamy	Green	Dark-brown	3.50	7.00
X± SD.							3.92±0.31	7.00±0.12
	Coarse	Coarse	Loamy	Loamy	Green	Dark-brown	4.10	6.50
CAS	Coarse	Coarse	Loamy	Loamy	Green	Dark-brown	3.45	6.51
	Coarse	Coarse	Loamy	Loamy	Dark-brown	Brown	3.07	6.50
X± SD.							3.54±0.43	6.50±0.22
	Fine	Fine	Clay	Clay	Green	Brown	4.21	7.00
IC	Coarse	Coarse	Clay	Clay	Green	Light-brown	3.51	7.00
	Fine	Fine	Clay	Loamy	Light-brown	Light-brown	4.00	7.00
X± SD.							3.90± 0.29	7.00±0.12
	Coarse	Coarse	Loamy	Loamy	Green	Brown	3.21	6.52
PS	Coarse	Coarse	Loamy	Loamy	Brown	Brown	4.02	6.53
	Coarse	Coarse	Loamy	Loamy	Dark-brown	Brown	5.01	6.51
X± SD.							4.0±0.12	6.52±0.09

Keys: LA=Lecture Area, CA=Control Area, CHS=College of Health Science, CAS=College of Agricultural Science, IC=Ishieke Campus, PS=Permanent Site, X=Mean, SD= Standard Deviation.

Table 2: Chemical Parameters of Soil Samples Contaminated with Urine and Control Around LectureTheatres in Ebonyi State University, Abakaliki.

	Conductivity (μ/cm)		Nitrate (mg/kg)		Phosphate (mg/kg)		Sulphate (mg/kg)	
Sample Codes	**LA**	**CA**	**LA**	**CA**	**LA**	**CA**	**LA**	**CA**
Campus								
CHS	88.07	55.09	7.10	3.28	6.86	5.44	7.87	5.06
	88.12	56.10	6.81	3.20	6.73	5.42	7.45	5.01
	85.15	55.08	6.90	3.26	6.68	4.90	6.89	5.00
X ± SD	**87.11±1.38**	**55.42±0.59**	**6.93±0.13**	**3.25±0.04**	**6.75±0.07**	**5.25±0.31**	**7.40±0.40**	**5.03±0.03**
CAS	87.11	53.09	6.90	3.06	6.82	4.36	6.58	4.52
	87.13	54.10	6.41	3.02	6.90	4.40	7.05	5.36
	86.14	54.10	5.82	3.07	5.66	4.42	6.87	5.30
X ± SD	**86.79±0.46**	**53.76±0.58**	**6.37±0.44**	**3.05±0.03**	**6.46±0.56**	**4.39±0.03**	**6.83±0.19**	**5.06±0.47**
IC	88.05	51.76	6.23	2.65	5.84	5.01	6.90	4.31
	87.12	53.11	7.01	2.70	6.75	4.71	7.72	4.32
	86.15	50.10	5.93	3.02	5.78	4.73	8.32	4.34
X ± SD	**87.10±0.77**	**51.66±1.53**	**6.39±0.45**	**2.79±0.20**	**6.12±0.44**	**4.82±0.17**	**7.64±0.58**	**4.32±0.02**
PS	86.08	45.53	5.91	2.54	6.67	4.01	7.70	4.86
	84.16	42.51	5.81	2.52	5.88	3.63	6.87	4.93
	85.11	41.60	6.50	2.50	5.69	3.58	8.00	5.00
X ± SD	**85.12±0.78**	**42.55±0.97**	**6.07±0.30**	**2.52±0.02**	**6.08±0.42**	**3.74±0.24**	**7.52±0.47**	**4.93±0.07**

Key: LA=Lecture Area, CA=Control Area, CHS=College of Health Science, CAS=College of Agricultural Science, IC=Ishieke Campus, PS=Permanent Sit, X=Mean, SD= Standard Deviation.

The results of exchangeable cations soil samples contaminated with urine (LA) and the control soil samples (CA). It reveals that sodium (Na^+) had the lowest mean± standard deviation values of 0.26±0.02 in the soil samples contaminated with urine (LA) when compared with the control soil samples (CA) with the highest mean value of 0.30±0.02. Potassium (K^+) showed the highest in the soil contaminated with urine (LA) with the mean value of 0.57±0.41 when compared with the control soilsample (CA) with the mean± standard deviation value of 0.18±0.02. Then, Calcium (Ca^+) showed the highest in the control soil sample (CA) with the mean standard deviation (±) value of 4.35± 0.73 when compared with the soil samples contaminated with urine (LA) having the lowest mean± standard deviation value of 3.16±0.21. Then, magnesium (Mg^+) showed the lowest mean± standard deviation value of 2.02±0.08 in the control soil (CA) when compared with soil samples contaminated with urine (LA) having the highest mean± standard deviation value of 2.37± 0.58. Antibiotic susceptibility and resistance profile of *Escherichia coli* isolated from soil samples contaminated with u rine revealed that the isolates were highly susceptible to cefotaxime 10(90.9%), gentamycin 9(81.8%), ciprofloxacin 8(72.7%) and least susceptible to meropenem 4(36.4%)but showed highest resistant tomupirocin, clindamycin,

ceftazidime, cefoxitin, oxacillin of 11(100%) each, followed by meropenem 7(63.6%) while cefotaxime 1(9.2%) showed least resistant out of eleven (11) isolates.

Table 3: Exchangeable Cations from Soil Samples Contaminated with Urine and Control Around Lecture Theatres in Ebonyi State University, Abakaliki.

	Exchangeable Cations							
	Na^+		K^+		Ca^+		Mg^+	
Sample Code	**LA**	**CA**	**LA**	**CA**	**LA**	**CA**	**LA**	**CA**
Campus								
	0.28	0.30	0.10	0.16	4.86	4.86	1.28	1.27
CHS	0.26	0.28	0.08	0.18	3.90	4.68	1.25	2.20
	0.25	0.32	0.16	0.20	1.89	3.52	2.14	2.59
X ± SD	**0.26±0.02**	**0.30±0.02**	**0.11±0.04**	**0.18±0.02**	**3.55±1.52**	**4.35±0.73**	**1.56±0.51**	**2.02±0.08**
CAS	0.27	0.22	0.14	0.18	2.97	3.43	0.89	0.26
	0.24	0.32	0.14	0.17	3.13	4.12	1.56	5.52
	0.19	0.25	0.08	0.15	3.39	4.14	0.89	0.24
X ± SD	**0.23±0.04**	**0.26±0.05**	**0.12±0.03**	**0.17±0.02**	**3.16±0.21**	**3.89±0.40**	**1.11±0.39**	**2.01±3.04**
IC	0.24	0.19	0.7	0.17	4.20	4.12	2.73	3.82
	0.24	0.32	0.9	0.17	3.50	4.30	2.68	1.14
	0.22	0.27	0.12	0.18	4.97	3.87	1.70	0.76
X ± SD	**0.23±0.01**	**0.26±0.07**	**0.57±0.41**	**0.17±0.01**	**4.22±0.74**	**4.09±022**	**2.37±0.58**	**1.91±1.67**
PS	0.23	0.27	0.41	0.20	0.12	2.57	2.86	0.92
	0.23	0.27	0.07	0.16	3.04	3.61	1.78	0.65
	0.18	0.25	0.05	0.15	5.72	4.41	1.77	2.52
X ± SD	**0.21±0.03**	**0.26±0.01**	**0.18±0.20**	**0.17±0.03**	**2.96±2.80**	**3.53±0.92**	**2.14±0.63**	**1.36±1.01**

Key: LA=Lecture Area, CA=Control Area, CHS=College of Health Science, CAS=College of Agricultural Science, IC=Ishieke Campus, PS=Permanent Site,X=Mean, SD= Standard Deviation.

Table 4: Antibiotic Susceptibility and Resistance Profile of *Escherichia coli* Isolated from Soil Samples Contaminated with Urine around Lecture Theatres in Ebonyi State University, Abakaliki.

S/N	Antibiotics	Susceptible (%)	Resistant (%)
1	CN	9(81.8)	2(18.2)
2	OX	0(0.0)	11(100)
3	FOX	0(0.0)	11(100)
4	CIP	8(72.7)	3(27.3)
5	AK	9(81.8)	2(18.2)
6	CM	0(0.0)	11(100)
7	MEM	4(36.4)	7(63.6)
8	MUP	0(0.0)	11(100)
9	CT	10(90.9)	1(9.2)
10	CAZ	0(0.0)	11(100)

Keys: Gentamycin (CN), Ciprofloxacin (CIP), Amikacin (AK), Clindamycin (CM), Meropenem (MEM), Mupirocin (MUP), Oxacillin (OX), Cefoxitin (FOX), Cefotaxime (CT), Ceftazidime (CAZ).

Antibiotic susceptibility and resistance profile of *Staphylococcus* species isolated from soil samples contaminate d with urine revealed that the isolates weretotally 9(100%) susceptible to cefoxitin and least susceptibility of 2(22.2%) to cefotaxime but highest resistant of 7(77.8%) to cefotaxime while least resistantwere observed in gentamycin with 2(22.2%) out of nine (9) isolates. Antibiotic susceptibility and resistance profile of *Enterobacter* species isolated from soil samples contaminate d with urine revealed that the isolates were highly susceptible to gentamycin, ciprofloxacin and cefotaxime 5(83.3%) each, and amikacin 4(66.7%) but totally resistant of 6(100%) to oxacillin, cefoxitin, clindamycin, meropenem and mupirocin and least resistant of 1(12.5%) to gentamycin, ciprofloxacin and cefotaxime out of six (6) isolates. Antibiotic susceptibility and resistance profile of *Pseudomonas* species isolated from soil samples contaminated with urine. The result shows that the isolates were highly susceptible to gentamycin and amikacin 6(75%) each, mupirocin and clindamycin 5(62.5%) each while least susceptibility of 1(12.5%) to meropenem and cefotaxime but totally resistant to oxacillin and ceftazidime 8(100%) and least resistant of 2(25%) to gentamycin and amikacin out of eight (8) isolates.

Table 5: Antibiotic Susceptibility and Resistance Profile of *Staphylococcus* species Isolated from Soil Samples Contaminated with Urine around Lecture Theatres in Ebonyi State University, Abakaliki.

S/N	Antibiotics	Susceptible (%)	Resistant (%)
1	CN	7(77.8)	2(22.2)
2	OX	4(44.4)	5(55.6)
3	FOX	9(100)	0(0.0)
4	CIP	6(66.7)	3(33.3)
5	AK	3(33.3)	6(66.7)
6	CM	3(33.3)	6(66.7)
7	MEM	5(55.6)	4(44.4)
8	MUP	3(33.3)	6(66.7)
9	CT	2(22.2)	7(77.8)
10	CAZ	3(33.3)	6(66.7)

Keys: Gentamycin (CN), Ciprofloxacin (CIP), Amikacin (AK), Clindamycin (CM), Meropenem (MEM), Mupirocin (MUP), Oxacillin (OX), Cefoxitin (FOX), Cefotaxime (CT), Ceftazidime (CAZ).

Table 6: Antibiotic Susceptibility and Resistance Profile of *Enterobacter* species Isolated from Soil Samples Contaminated with Urine around Lecture Theatres in Ebonyi State University, Abakaliki.

S/N	Antibiotics	Susceptible (%)	Resistant (%)
1	CN	5 (83.3)	1 (12.5)
2	OX	0 (0.0)	6 (100)
3	FOX	0 (0.0)	6 (100)
4	CIP	5 (83.3)	1 (12.5)
5	AK	4 (66.7)	2 (33.3)
6	CM	0 (0.0)	6 (100)
7	MEM	0 (0.0)	6 (100)
8	MUP	0 (0.0)	6 (100)
9	CT	5 (83.3)	1 (12.5)
10	CAZ	0 (0.0)	6 (100)

Keys: Gentamycin (CN), Ciprofloxacin (CIP), Amikacin (AK), Clindamycin (CM), Meropenem (MEM), Mupirocin (MUP), Oxacillin (OX), Cefoxitin (FOX), Cefotaxime (CT), Ceftazidime (CAZ).

Table 7: Antibiotic Susceptibility and Resistance Profile of *Pseudomonas* species Isolated from Soil Samples Contaminated with Urine around Lecture Theatres in Ebonyi State University, Abakaliki.

S/N	Antibiotics	Susceptible (%)	Resistant (%)
1	CN	6 (75)	2 (25)
2	OX	0 (0.0)	8 (100)
3	FOX	2 (25)	6 (75)
4	CIP	2 (25)	6 (75)
5	AK	6 (75)	2 (25)
6	CM	5 (62.5)	3(37.5)
7	MEM	1 (12.5)	7 (87.5)
8	MUP	5 (62.5.7)	3 (37.5)
9	CT	1 (12.5)	7 (87.5)
10	CAZ	0 (0.0)	8 (100)

Keys: Gentamycin (CN), Ciprofloxacin (CIP), Amikacin (AK), Clindamycin (CM), Meropenem (MEM), Mupirocin (MUP), Oxacillin (OX), Cefoxitin (FOX), Cefotaxime (CT), Ceftazidime (CAZ).

Antibiotic susceptibility and resistance profile of *Klebsiella* species isolated from soil samples contaminated with urine.The result shows that the isolates were highly susceptible to gentamycin and cefotaxime 9(81.8%) each, ciprofloxacin and mupirocin 8(72.7%) each while amikacin 5(45.5%) showed least susceptible when compared to other antibiotics but totally resistant to oxacillin, cefoxitin, clindamycin, meropenem and ceftazidime 11(100%) each while least resistant were observed in gentamycin and cefotaxime 2(18.2%) each out of eleven (11) isolates. Antibiotic susceptibility and resistance profile of *Proteus* species isolated from soil samples contaminated with Urine. That the isolates were highly susceptible to ciprofloxacin 9(90%), gentamycin 8(80%), amikacin and cefotaxime 7(70%) each, oxacillin and cefoxitin 6(60%) each but totally resistant to clindamycin, meropenem, mupirocin and ceftazidime 10(100%) each, followed by oxacillin and cefoxitin 4(40%) each while least resistant were observed in 1(10%) to ciprofloxacin out of ten (10) isolates. Antibiotic Susceptibility and Resistance Profile of *Bacillus*species.Isolated from Soil Sampl es Contaminated with Urine.The isolates showed varying percentage of susceptibility and resistant to gentamycin and oxacillin 4(80%) each, clindamycin 3(60%), cefoxitin and ciprofloxacin 3(60%)

each, and 2(40%) to mupirocin and least susceptibility of to meropenem 1(20%)but totally resistant to amikacin, cefotaxime and ceftazidime 5(100%) each, followed by meropenem 4(80%), mupirocin 3(60%), cefoxitin and ciprofloxacin 2(40%)each while least resistant of 1(20%) to (gentamycin , oxacillin and cefoxitin) each out of eleven (11) isolates.

Table 8: Antibiotic Susceptibility and Resistance Profile of *Klebsiella* species Isolated from Soil Samples Contaminated with Urine around Lecture Theatres in Ebonyi State University, Abakaliki.

S/N	Antibiotics	Susceptible (%)	Resistant (%)
1	CN	9 (81.8)	2 (18.2)
2	OX	0 (0.0)	11 (100)
3	FOX	0 (0.0)	11 (100)
4	CIP	8 (72.7)	3 (27.3)
5	AK	5 (45.5)	4 (36.4)
6	CM	0 (0.0)	11 (100)
7	MEM	0 (0.0)	11 (100)
8	MUP	8 (72.7)	3 (27.3)
9	CT	9 (81.8)	2 (18.2)
10	CAZ	0 (0.0)	11(1 00)

Keys: Gentamycin (CN), Ciprofloxacin (CIP), Amikacin (AK), Clindamycin (CM), Meropenem (MEM), Mupirocin (MUP), Oxacillin (OX), Cefoxitin (FOX), Cefotaxime (CT), Ceftazidime (CAZ).

Table 9: Antibiotic Susceptibility and Resistance Profile of *Proteus* species Isolated from Soil Samples Contaminated with Urine around Lecture Theatres in Ebonyi State University, Abakaliki.

S/N	Antibiotics	Susceptible (%)	Resistant (%)
1	CN	8(80)	2(20)
2	OX	6(60)	4(40)
3	FOX	6(60)	4(40)
4	CIP	9(90)	1(10)
5	AK	7(70)	3(30)
6	CM	0(0.0)	10(100)
7	MEM	0(0.0)	10(100)
8	MUP	0(0.0)	10(100)
9	CT	7(70)	3(30)
10	CAZ	0(0.0)	10(100)

Number of isolates = 10

Keys: Gentamycin (CN), Ciprofloxacin (CIP), Amikacin (AK), Clindamycin (CM), Meropenem (MEM), Mupirocin (MUP), Oxacillin (OX), Cefoxitin (FOX), Cefotaxime (CT), Ceftazidime (CAZ).

Table 10: Antibiotic Susceptibility and Resistance Profile of *Bacillus* species Isolated from Soil Samples Contaminated with Urine around Lecture Theatres in Ebonyi State University, Abakaliki.

S/N	Antibiotics	Susceptible (%)	Resistant (%)
1	CN	4(80)	1(20)
2	OX	4(80)	1(20)
3	FOX	4(80)	1(20)
4	CIP	3(60)	2(40)
5	AK	0(0.0)	5(100)
6	CM	3(60)	2(40)
7	MEM	1(20)	4(80)
8	MUP	2(40)	3(60)
9	CT	0(0.0)	5(100)
10	CAZ	0(0.0)	5(100)

Keys: Gentamycin (CN), Ciprofloxacin (CIP), Amikacin (AK), Clindamycin (CM), Meropenem (MEM), Mupirocin (MUP), Oxacillin (OX), Cefoxitin (FOX), Cefotaxime (CT), Ceftazidime (CAZ).

Antibiotic susceptibility and resistance profile of *Streptococcus* species isolated from soil samples contaminate d with urine. The isolates showed were totally susceptible of 5(100%) to cefotaxime and lowest susceptibility of 1(20%) to meropenem and mupirocin but highest resistant of 5(100%) to ceftazidime and least resistant of 1(20%) to ciprofloxacin each out of five (5) isolates. The Result of multiple antibiotics resistance index (MARI) of bacteria isolated from soil samples contaminated with urine around lecture theatres in Ebonyi State University, Abakaliki. Results obtained revealed that among the bacteria isolated from soil samples contaminated with urine around lecture theatres in four campuses of Ebonyi State University, Abakaliki; *Enterobacter* species had the highest average MARI value of 0.68, followed by *Pseudomonas* species with the average MARI value of 0.66 while *Staphylococcus* species showed the lowest average MARI value of 0.51.

Table 11: Antibiotic Susceptibility and Resistance Profile of *Streptococcus* species Isolated from Soil Samples Contaminated with Urine around Lecture Theatres in Ebonyi State University, Abakaliki.

S/N	Antibiotics	Susceptible (%)	Resistant (%)
1	CN	3 (60)	2 (40)
2	OX	2 (40)	3 (60)
3	FOX	2 (40)	3 (60)
4	CIP	4 (80)	1 (20)
5	AK	2 (40)	3(60)
6	CM	3 (60)	2 (40)
7	MEM	1 (20)	4 (80)
8	MUP	1 (20)	4 (80)
9	CT	5 (100)	0 (0.0)
10	CAZ	0 (0.0)	5 (100)

Number of isolates = 5

Keys: Gentamycin (CN), Ciprofloxacin (CIP), Amikacin (AK), Clindamycin (CM), Meropenem (MEM), Mupirocin (MUP), Oxacillin (OX), Cefoxitin (FOX), Cefotaxime (CT), Ceftazidime (CAZ).

Table 12: MARI Value of *Escherichia coli* from Soil Samples Contaminated with urine Around Lecture Theatres in Ebonyi State University, Abakaliki.

ISOLATE CODE	MARI VALUE
Eco 1	0.5
Eco 2	0.5
Eco 3	0.6
Eco 4	0.7
Eco 5	0.7
Eco 6	0.6
Eco 7	0.7
Eco 8	0.7
Eco 9	0.7
Eco 10	0.7
Eco 11	0.6
Total	**63 Average= 0.57**

Table 13:MARI Value of *Staphylococcus* species from Soil Samples Contaminated with Urine around Lecture Theatres in Ebonyi State University, Abakaliki.

ISOLATE CODE	MARI VALUE
Staph 1	0.5
Staph 2	0.5
Staph 3	0.3
Staph 4	0.5
Staph 5	0.6
Staph 6	06
Staph 7	0.5
Staph 8	0.5
Staph 9	0.6
Total	**4.6 Average = 0.51**

Table 14:MARI Value of *Enterobacter* species from Soil Samples Contaminated with urine around Lecture Theatres in Ebonyi State University, Abakaliki.

ISOLATE CODE	MARI VALUE
Ent 1	0.7
*Ent*2	0.7
Ent 3	0.7
Ent 4	0.7
*Ent*5	0.6
Ent 6	0.7
Total	**4.1 Average = 0.68**

Table 15:MARI Value of *Pseudomonas* species from Soil Samples Contaminated with Urine around Lecture Theatres in Ebonyi State University, Abakaliki.

ISOLATE CODE	MARI VALUE
*Pseu*1	0.6
*Pseu*2	0.6
*Pseu*3	0.7
*Pseu*4	0.6
*Pseu*5	0.6
*Pseu*6	0.7
*Pseu*7	0.8
*Pseu*8	0.7
Total	**5.3 Average = 0.66**

Table 16:MARI Value of *Klebsiella* species from Soil Samples Contaminated with urine Around Lecture Theatres in Ebonyi State University, Abakaliki.

ISOLATE CODE	MARI VALUE
*Kleb*1	0.5
Kleb 2	0.6
*Kleb*3	0.7
*Kleb*4	0.5
*Kleb*5	0.8
Kleb 6	0.8
*Kleb*7	0.6
*Kleb*8	0.6
Kleb 9	0.6
Kleb 10	0.8
Kleb 11	0.7
Total	**7.2 Average = 0.65**

Table 17:MARI Value of *Proteus* species from Soil Samples Contaminated with urine around lecture theatres in Ebonyi State University, Abakaliki.

ISLOTE CODE	MARI VALUE
*Prot*1	0.5
Prot 2	O.6
*Prot*3	0.5
*Prot*4	0.6
*Prot*5	0.6
*Prot*6	0.4
Prot 7	0.5
*Prot*8	0.6
*Prot*9	0.7
*Prot*10	0.7
Total	**5.7 Average = 0.57**

Table 18:MARI Value of *Bacillus* species from Soil Samples Contaminated with urine around Lecture Theatres in Ebonyi State University, Abakaliki.

ISOLATE CODE	MARI VALUE
*Bac*1	0.5
*Bac*2	0.6
*Bac*3	0.7
*Bac*4	0.5
*Bac*5	0.6
Total	**2.9 Average =0.58**

Table 19:MARI Value of *Streptococcus* species from Soil Samples Contaminated with Urine around Lecture Theatres in Ebonyi State University, Abakaliki.

ISOLATE CODE	MARI VALUE
Strep 1	0.5
*Strep*2	0.4
*Strep*3	0.7
*Strep*4	0.5
*Strep*5	0.5
Total	**2.3 Average = 0.52**

DISCUSSION

This study focuses on antibiogram of bacterial isolates and physicochemical analysis of soils contaminated with urine around lecture theatres in Ebonyi State University, Abakaliki. A total of 24 soil samples contaminated with urine and control soil samples were used in this study. The results of physical parameters

of soil samples contaminated with urine and control revealed that some soil contaminated with urine and control samples were coarse and fine (texture); loamy and clay (soil type), dark- brown, light-brown, or brown and green (colour). The variation in colour may be due to the differences in the concentrations of urine in the soil samples collected. In the soils not used for agricultural purposes urease activity is therefore expected to be minimal in non-contaminated areas due to lack of nitrogen. However, in urine contaminated areas an increase in urease activity was expected. In a study by [22] looking at urease activity between garden and urinated soil, a colour change of urease-based agar from green to pink served as a direct indicator for the presence of urease rich bacteria. In an agricultural setting, the enhanced urease activity can be an early indicator for improved soil fertility [23]. In the soil contaminated with urine, the pH value ranged from 3.07-5.01 with the mean± standard deviation value ranging from 3.54±0.43 to 4.08±0.12; showing that the soil samples contaminated with urine were acidic due to urine concentration while in the control soil samples, the pH value also ranges between6.50 – 7.00 with the mean± standard deviation value ranging between6.50±0.22 to 7.00±0.12; showing that the soils were slightly acidic or neutral. [24], also reported on the effect of pH, enzyme activity, substrate concentration and temperature on microbial urease activity. However, the differences in soil pH mean standard deviation in different locations for the contaminated soil were observed to be statistically significant ($p<0.05$).These microbes may possess or have acquired the genetic attributes that enabled them to survive in such acidic environment. There was a significant increase ($p<0.05$) in the mean± standard deviation of the physicochemical parameters such as conductivity, nitrate, phosphate, sulphate from the soil samples contaminated with urine (LA) when compared to the control soil samples (CA). It reveals that College Health Science (CHS) had the highest mean± standard deviation values of 87.11±1.38 for conductivity, 6.93±0.13 for nitrate, 6.75±0.07 for phosphate and 7.64±0.58 for sulphate in Ishieke campus. Meanwhile the control soil samples (CA) had the highest mean± standard deviation values of 55.42±0.59 for conductivity, 3.25±0.04 for nitrate, 5.25±0.31 for phosphate in the same College Health Science (CHS), and 5.06±0.47 for sulphate in College Agricultural Science (CAS) but lower when compared to the contaminated soil samples in our findings. The high values of chemical parameters observed in the urine contaminated soil is in agreement with the results of a similar study conducted by [25], who recorded a significant increase in SO_4 (0.004±0.02), NO_3(0.009±0.001), NH_3(0.019±0.001) and PO_4(0.06±0.006) in the soil contaminated with urine when compared with the control soil with SO_4(0.002±0.002), NO_3(0.005±0.01), NH_3(0.02±0.001) and PO_4(0.024±0.004). Clapp *et al.*, (2005) also reported asignificantly higher values of PO_4(0.045±0.005), NO_3(0.009±0.004) and SO_4(0.005±0.002) from urine contaminated soil when compared withuncontaminated Soil with PO_4(0.022±0.006), NO_3 (0.004±0.001) and SO_4 (0.002±0.001). The major physical impact of urine deposition on soil is the significantly lower pH, indicating high soil acidity. This is as a result of microbial oxidative process of urea which takes place in urine contaminated soil. The high acidity will greatly interfere with nutrient cycling between soils, air and water to the extent that higher deposition and dissolution of nutrients will occur in urine contaminated soil, hence the significantly higher content of PO_4, NO_3 and SO_4 recorded from urine contaminated soil. There was a significant variation ($p<0.05$) in the mean± standard deviation of the exchangeable cations among soil samples contaminated with urine (LA) when compared with the control soil samples (CA). Statistical analysis showed that the urine contaminated soils had significant ($p<0.05$) effects on the Na^+, K^+, Ca^+ and Mg^+. The mean standard deviation of exchangeable cations at the soil samples

indicated that there were significant differences among soil samples contaminated with urine (LA) control soil samples (CA). It was earlier revealed that when soils become acidic their capacity to adsorb cations is reduced, hence the loss of such cations from the soils by leaching [26]. These increases in the cations especially calcium (Ca^{+}) and magnesium (Mg^{+}) in the soil samples contaminated with urine could have been caused by the urine concentration. The result of antibiotic susceptibility profile of bacterial isolates from soil contaminated with urine around lecture theatresshows that *Escherichia coli* were highly susceptible to cefotaxime (90.9%), gentamycin (81.8%), amikacin (81.8%), and ciprofloxacin(72.7%)but resistant to oxacillin, cefoxitin, clindamycin, ceftazidime (100%) respectively, followed by meropenem with (63.6%) while least resistance was observed in cefotaxime (9.2%). This is in agreement with the work of Ajah *et al*. (2016) who reported resistance of *E. coli* to third generation cephalosporin such as ceftazidime (83.7 %), and cefotaxime (97.2 %).This could be attributed to the fact that most treatments were done without antibiotic susceptibility testing and thus aggravates incidence of recurrent infection with more resistant strains [27]. In this study, the diverse antibiotic sensitivity pattern of the bacterial isolates observed is comparable with the report of [8], who reported *E. coli* sensitivity of 13(76.5 %) to gentamycin. In*Staphylococcus* species, it was observed that the isolates were 100% susceptible to cefoxitin followed by ciprofloxacin (88.9%), gentamycin (77.8%), clindamycin (77.8%), oxacillin and meropenem (66.7%). However, some of the *Staphylococcus* species showed 77.8% resistant to cefotaxime, 66.7% toamikacin and ceftazidime respectively in our finding. *Enterobacter* species were highly susceptible to gentamycin and cefoxitin (83.3%) each, followed by ciprofloxacin and amikacin (66.7%) each when compared to other isolates which showed(100%) resistant to oxacillin, clindamycin, meropenem, mupirocin and ceftazidime in our finding(Table 9).Again, *Pseudomonas* species were highly susceptible to gentamycin and amikacin (75%) each, clindamycin and mupirocin (62.5%) each but totally resistant to oxacillin and ceftazidime (100%), followed by mupirocin and cefoxitin (87.5%) each, cefoxitin and ciprofloxacin (75%) each. This is in line with work done by [28]. *Klebsiella* species were highly susceptible to gentamycin and cefotaxime (81.8%) each, ciprofloxacin and mupirocin (72.7%) each and amikacin (45.5%) but totally resistant to oxacillin and ceftazidime (100%) each. This is also in line with the report of [22], who reported that *Klebsiella pneumonia* had sensitivity of 14(77.7 %) to gentamycin. Moreover,*Proteus* species were highly susceptible to ciprofloxacin (90%), gentamycin (80%), amikacin and cefotaxime (70%) each, oxacillin and cefoxitin (60%) while some isolates were 100% resistant to meropenem, mupirocin, clindamycin and ceftazidime when compared to other isolates which showed less resistantto the tested antibiotics. Meanwhile, some*Bacillus* species were highly susceptible to gentamycin and oxacillin (80%) each., ciprofloxacin and clindamycin (60%) eachwhen compared to other species which showed lowest susceptibility to mupirocin (40%) and meropenem(20%).Some of the *Bacillus* species also were 100% resistant to amikacin, cefotaxime and ceftazidime, followed by meropenem (80%), mupirocin (60%), cefoxitin and ciprofloxacin (40%) each when compared to other isolates which showed lowest resistant to tested antibiotics.Antibiotic resistance among Gram negative rods*Enterobacteriaceae* such as *E. coli* and *Klebsiella* is on the increase. This has made treatment related to these organisms difficult in our hospitals and has also led to increase in health care cost, mortality, morbidity and pressure on both social and economic conditions of patients and communities [21]. This observation compares favorably with the reports made by [22] that Gram-negative bacteria have the highest sensitivity to gentamycin and ciprofloxacin. The highest efficacy of gentamicin in the treatment of UTIs has

been reported by [26]. *Streptococcus* specieswas 100% susceptible to cefotaxime followed by gentamycin, cefoxitin and ciprofloxacin (80%) each, oxacillin, amikacin and clindamycin (40%) each;but 100% resistant to ceftazidimefollowed by mupirocin (80%), meropenem (60%), oxacillin and clindamycin (40%) each. This is in line with the report of [20], who worked on isolation, identification and characterization of urinary tract infections bacteria and the effect of different antibiotics. The result of MARI showed that out of the Gram-positive bacteria isolated, *Staphylococcus* species had the lowest average MARI value of (0.51) while out of the Gram-negative bacteria isolated; *Enterobacter* species had the highest average MARI value of (0.68). Therefore, MARI is a tool that reveals the spread of bacterial resistance in a given population [18],[19].

CONCLUSION

The results of this study revealed that the soils contaminated with urine increases the population of most pathogenic bacteria as only eight (8) bacteria was isolated from the 24 samples collected for this study. The pH of soil samples contaminated with urine was acidic due to urine concentration whereas the pH of the control soil samples was slightly acidic or neutral. There was significant increase in the physicochemical parameters of soil contaminated with urine than the control in conductivity, nitrate, phosphate and sulphate whereas the exchangeable cations (Na^+, K^+, Ca^+ and Mg^+) had significant variation in the soil contaminated with urine and the control soil. The bacterial isolates were generally susceptible to gentamycin and ciprofloxacin but totally resistant to ceftazidime(100%) except *Staphylococcus* spp. The result of MARI showed that out of the Gram-positive bacteria isolated, *Staphylococcus* species had the lowest average MARI value of (0.51) while out of the Gram-negative bacteria isolated *Enterobacter* species had the highest average MARI value of (0.68).

RECOMMENDATIONS

The practice and enforcement of basic sanitation rules would help prevent unnecessary deaths and protect the health of millions of persons. The University should know the number of students to admit, and number of staff to employ to prevent over population that can lead to indoctrinate urination around lecture theatres. They should be provision of more and adequate toilet facilities within the institution.Water closet toilet type could also be made available within the institution. Post-infection human pathogenic organisms may be excreted in large numbers in biological specimens such as urine which will result to increasing bacterial load above threshold levels within the body systems and environmental pollution. If Post-infection human pathogens occur, it is advisable to take gentamycin and ciprofloxacin as therapeutic measure to combat the infectious agents especially the one that can cause urinary tract infections (UTI).

REFERENCES

1. Amundson, N. and Ronald, R. (2017).Soil preservation and the future of pedology. Faculty of Natural Resources.Prince of Songkla University, Songkhla, Thailand.
2. Andersson, D.I and Hughes, D. (2011).Persistence of antibiotic resistance in bacterial populations.*Microbiology Reviews,***35** (5): 901–11.
3. Arias, F. (2008).Abnormalities of the Urinary System during Pregnancy. In: Daftary, S.N. and Bhide, A.G (Editors). Practical Guide to High Risk Pregnancy and Delivery.A South Asian Perspective.3rd edition New Delhi: Elsevier Publishers, P 489–505.
4. Arnold, S. R. and Straus, S. E. (2005).Interventions to improve antibiotic prescribing practices in

ambulatory care. *The Cochrane Database of Systematic Reviews,***4**: 170– 173.

5. Arthur, C. G. and John, E. H. (2006).*Textbook of medical physiology* (11edition). Elsevier Saunders. ISBN 978-0-8089-2317-6.
6. Bannerman, T. L. and Peacock, S. J. (2007).*Staphylococcus, Micrococcus* and other catalase- positive cocci. In: P. R. Murray, E. J. Baron, J. H. Jorgensen, M. L. Landry and M. A. Pfaller(Educations).*Manual of clini cal microbiology* (9thed., PP 390-404). Washington, USA: ASM Press.
7. Bansode, V. M., Vagge, S. T. and Kolekar, A. B. (2015).Relationship between soil properties and corrosion of steel pipe in alkaline soils (PDF). *International Journal of Research and Scientific Innovation,* **2** (11): 57–61.
8. Baur, D., Gladstone, B.P., Burkert, F., Carrara, E., Foschi, F., Döbele, S. and Tacconell, I. E. (2017). Effect of antibiotic stewardship on the incidence of infection and colonisation with antibiotic-resistant bacteria and Clostridium difficile infection: a systematic review and meta-analysis. *The Latent Infectious Diseases,***17** (9): 990–1001.
9. Bridge, P. and Spooner, B. (2001).Soil Bacteria: Diversity and Detection. *Plant and Soil Contamination,***232**(1-2):147-154.
10. Brooks, M. (2015).Public Confused About Antibiotic Resistance, World Health Organization(WHO) Says. *Medical capeMultispecialty*, **2**: 23 – 32.
11. Calderon, C. B. and Sabundayo, B. P.(2007).AntimicrobialClassificatio ns of an InfectiousAgent. In Schwalbe R, Steele-Moore L, Goodwin AC. Antimicrobial SusceptibilityTestingProtocols.CRC Press. Taylor and Frances group. 342
12. Canfield, R. L., Henderson, C. R. Jr., Cory-Slechta, D. A., Cox, C., Jusko, T. A. and Lanphear, B. P. (2003). International Sellectual impairment in children with blood concentrations below 10 μg per deciliter.*New EnglandJournal of Medicine,***348**:1517–1526.
13. Cheesbrough, M. (2002). District laboratory practice in Tropical countries, Cheesbrough, M. 2ndEdition. Cambridge University press, Chembridge, UK; P 63-70.
14. Drangert, J. O. (2000). Resuse– The ultimate sink: Urine-diverting toilets to protect groundwater quality and fertilize urban agriculture. In: Chorus, I., Ringelband, G. Schla, G and Schmll, O. (educations), Water, sanitation and health. Proceedings of the International Conference, Bad Elser, Germany, 24-28 November, 1998. IWA Publishing, London, UK. Pp. 275-280.
15. Dykhuizen, D. E. (1998).Santa Rosalia revisited: why are there so many species of bacteria. *Antonie van Leeuwenhoek.***73** (1): 25–33.
16. Ejikeugwu, P. C., Ugwu, C. M., Araka, C. O., Gugu, T. H., Iroha I. R., Adikwu, M. U. and Esimone, C. O. (2012). Imipenem and Meropenem Resistance amongst ESBL Producing*Escherichia coli* and *Kle bsiella pneumonia* clinical isolate s. *International Research Journal of Microbiology*, 3(**10**): 339 – 344
17. Elaine, I. R. (2009). The soil quality concept.United State Department of Agriculture (USDA). National Resource Conservation Services (NRCS). Oregon State University.
18. Epstein, H. E., Burke, I. C. and Lauenroth, W. K. (2002).Regional patterns of decomposition and primary production rates in the U.S. Great Plains. *Ecology,***83** (2): 320–27.
19. Lee, K. E. and Foster, R. C. (2003).Soil fauna and soil structure. *Australian Journal of Soil Research*,**29** (6): 745–75.
20. Onoh, R. C., Umeora, O. U. J., Egwuatu, V. E., Ezeonu, P. O. and Onoh, T. J. P.

(2013). Antibiotic Sensitivity Pattern of Uropathogens From Pregnant Women with Urinary Tract Infection in Abakaliki, Nigeria. *Journal of Infection and Drug Resistance,* **6**: 225–233.

21. Onu, G.A., Korir, S. C., Cheruiyot, J. C., Ratemo, O. D. and Mabeya, B.M. (2013). Isolation, identification and characterization of urinary tract infections bacteria and the effect of different antibiotics. *Journal National Science Resources,***3**: 150-159.
22. Ozcep, F., Yıldırım, E., Tezel, O., Asci, M. and Karabulut, S.(2010). Correlation between electrical resistivity and soil-water content based artificial intelligent techniques" (PDF).*International Journal of Physical Sciences,***5** (1): 47–56.
23. Pechère, J. C.(2001). Patients interviews and misuse of antibiotics. *Clinical Infectious Diseases,* 3: 170–3.
24. Ugwu, M. C., Odimegwu, D. C., Ibezim, E. C. and Esimone, C.O. (2009). Antibiotic Resistance Patterns of *Staphylococcus aureus* Isolatedfrom Nostrils of Healthy Human Subjects in a South Eastern Nigeria Locality. *Macedonian Journal of Medical Sciences*, 2(**4**): 294–300.
25. Uroz, S., Calvaruso, C., Turpault, M. and Frey-Klett, P. (2009). Mineral weathering by bacteria: ecology, actors and mechanisms. *Trends in Microbiology,***17** (8): 378–87.
26. World Health Organization (WHO).(2005). Urinary Tract Infections in Infants and ChildreninDeveloping Countries i n the Context of IMCI. Retrieved from, http://www.who.int/drugr esistance/publications/infographic -antimicrobial-resistance-20140430.pdf?ua=1
27. Yu, C., Kamboj, S., Wang, C. and Cheng, J.(2015). Data collection handbook to support modeling impacts of radioactive material in soil and building structures.*Argonne National Laboratory*, 13–21.
28. Zhang, T., Wan, S., Kang, Y. and Feng, H. (2014).Urease activity and its relationships to Soil physiochemical properties in a highly saline-sodic soil. *Journal of Soil Science and Plant Nutrition*, **14**(2), 304-315.