



ASSESSMENT OF MICROBIOLOGICAL AND PHYSIOCHEMICAL PROPERTIES OF WASTEWATER FROM RESTAURANTS IN AKURE, NIGERIA

Ogidi, C. O. & Oyetayo, V. O.

Department of Microbiology, Federal University of Technology, P.M.B 704, Akure, Nigeria

ABSTRACT

The microbial and physiochemical properties of wastewater from restaurants in Akure metropolis was investigated using standard techniques. The mean value of bacteria count ranged from 5.5×10^7 cfu/ml to 7.4×10^7 cfu/ml while fungal count ranged from 4.1×10^4 sfu/ml to 5.2×10^4 sfu/ml. The bacteria isolates were *Klebsiella pneumoniae*, *Staphylococcus aureus*, *Shigella dysenteriae*, *Escherichia coli*, *Micrococcus luteus*, *Serratia marcescens* and *Proteus vulgaris*. Fungal isolates include *Aspergillus*, *Fusarium*, *Penicillium*, *Triscelosporus*. *Staphylococcus aureus* and *Shigella dysenteriae* were frequently isolated (22.2%). Physiochemical parameter of wastewater samples such as pH, temperature, total suspended solids (TSS), biochemical oxygen demand (BOD) fall within the range of the Federal environment protection agency (FEPA) effluent specification. This study reveals that indiscriminate discharge of wastewater into the environment may pose serious health implication due to the presence of pathogenic microorganisms in such wastewater samples.

KEYWORDS: wastewater, microorganisms, restaurants, physiochemical properties

INTRODUCTION

There has been increase in the number of restaurants in Akure metropolis in the last ten years. This is as a result of growth in population and commercial activities. In providing services in food canteens and restaurants, wastewater and leftover foods are generated. Wastewater contains substances like solids either dissolved or suspended solids, organic, inorganic matter, toxic compound, and microorganisms (Techobanoglous *et al.*, 2003). These substances originate from food wastes, various washing from kitchen, laundry, industrial wastes and run-off. Thus wastewater encompasses wide range of potential contaminants (Sulieman *et al.*, 2010). Moreover, wastewater contains high level of nutrients which when excessively released into the environment creates undesirable growth of microorganisms and eutrophication (Akpor *et al.*, 2008). Wastewater is directly discharged into the environment through drainage, open space or on the ground within the neighborhoods. This action may increase the microbial load of surface and ground water that serve as domestic water supply or create obnoxious odour to the environment. Wastewaters released from restaurants are characterized by the presence of synthetic detergents which had been known to be surfactants that is responsible for the cleaning action of detergents (Adewoye, 2010). Detergents are xenobiotics that will lead to accumulation of toxic products in receiving water bodies, and increase incidence of water borne disease with serious consequence on the ecosystem. Generally, the indiscriminate dumping of untreated wastes into the environment brings about physical, chemical and

biological deterioration of water bodies. The present study is therefore aimed at ascertaining the physiochemical properties, microbial load and type of organisms that associated with wastewater from restaurants in Akure metropolis.

MATERIALS AND METHODS

Study Area

Akure is a city in the south western region of Nigeria. It is the largest city and capital of Ondo State. Its geographic coordinates are $7^{\circ} 15' 0''$ North $5^{\circ} 12' 0''$ East. In this study, Akure metropolis was divided to four location comprising of Location **A** (Isinkan, Ondo Road, Fanibi, Ajipowo, Danjumon, Saw mill, Champion Eviron.); Location **B** (FUTA Side, Aule, Leo ,OritaObele, Ilesha Garage, Lafe, EyinAla); Location **C** (are OkeIjebu, Ijapo, Omolere, Owo-Ado Express Road, Onyearugbulem, Shagari, Araromi, Sabo Area) and Location **D** (OkeAro, Ijoka, Alagbaka, Oda-Road, Oshinle, Oluwatuyi,I danre Road).

Collection of wastewater

Samples of wastewater were collected in restaurants from the four different locations designated A, B, C and D above. Ten (10) restaurants each were used as sampling units in each location. Plastic containers used for sample collection were disinfected using (75% v/v) ethanol and rinsed with wastewater from the source prior to collection. The plastic containers were filled leaving about 30mm of empty space to allow mixing during laboratory analysis (Buckalew *et al.*, 2006). The samples were analyzed immediately after collection.

Microbial examination of wastewater samples

Media used in this study were prepared and sterilized according to manufacturer's instruction. The media are plate count agar (PCA) and potato dextrose agar (PDA). Stepwise serial dilutions of wastewater samples were carried out and appropriate dilution 10^{-6} for bacteria and 10^{-4} for fungi were plated on PCA and PDA respectively in triplicates. The plates were incubated for 24 hours at 37°C and $28\pm 2^{\circ}\text{C}$ for 48 hours for bacteria and fungi respectively. The microbial load and cultural characteristics were observed according to standard microbiological techniques. Pure cultures were isolated, Gram stained, followed by biochemical tests to identify the isolates. The biochemical tests include; motility, catalase, indole production, citrate utilization, oxidase, Voges Proskauer, methyl red and sugar utilization such as; glucose, lactose, sucrose, maltose, mannitol and inositol (Cappucino and Sherman, 1998; Olutiola *et al.*, 2000). These tests were used to identify the isolates to strain level according to Cowan and Steel (1993). Microscopic identification of fungi was done according to Barnett *et al.* (1983).

Determination of physiochemical properties

The physiochemical parameters determined were Hydrogen ion concentration (pH), temperature, turbidity etc. The pH, temperature, salinity, total dissolved solids and conductivity of wastewater samples were determined with multiparameter HANNA HI9828. The electrode of multiparameter was dipped into a beaker containing 100ml of wastewater for 10 minutes at room temperature.

Microprocessor turbidity meter HANNA HI93703 was used to determine the turbidity of wastewater sampled. Gravimetric method involving filtration and evaporation was used to measure the total suspended solids.

Determination of Biochemical oxygen demand

Method recommended by APHA (1998) was followed to determine the biochemical oxygen demand (BOD). Wastewater samples were drawn into 250ml bottle, incubated in dark for 5 days at 20°C . At the end of 5 days, the final dissolved oxygen (DO) was determined using dissolved oxygen analyzer (JPB -607). The values of each parameter were taken in triplicate.

Data analysis

Data obtained were analyzed using analysis of variance (ANOVA) and mean were separated using Duncan's Multiple Rang Test (SPSS 15 version). Differences were considered significant at $p \geq 0.05$.

RESULTS

The microbial load of wastewater sampled from restaurants in Akure metropolis is presented in Table 1. The mean bacteria count ranged from 5.5×10^7 cfu/ml to 7.4×10^7 cfu/ml and fungal count ranged from 4.1×10^4 sfu/ml to 5.2×10^4 sfu/ml. The microorganisms isolated and their distributions in the different locations are shown in Tables 2 and 3. The mean values of physiochemical parameters of wastewater collected from restaurants are presented in Table 4. The pH value ranged from 7.20 to 7.39. Dissolved oxygen of 3.70 to 8.05mg/ml and turbidity of 36.9 to 46.0 Nephelometric turbidity unit (NTU)

TABLE 1: Microbial load of wastewater samples from restaurants in Akure metropolis

Parameters	LA	LB	LC	LD
Total bacterial counts (cfu/ml)	5.9×10^7	5.8×10^7	7.4×10^7	5.5×10^7
Fungal counts (sfu/ml)	5.2×10^4	4.5×10^4	4.1×10^4	4.9×10^4

Key: LA= Mean value from location A; LB= Mean value from location B; LC= Mean value from location C; LD= Mean value from location D

TABLE 2: Distribution of bacterial isolates in wastewater sampled from different locations

Organisms	LA	LB	LC	LD	No of Isolates	% Occurrence
<i>Staphylococcus aureus</i>	+	+	+	+	10	22.2
<i>Shigella dysenteriae</i>	+	+	+	-	10	22.2
<i>Enterobacter aerogenes</i>	+	+	+	+	8	17.8
<i>Escherichia coli</i>	+	-	+	+	6	13.3
<i>Klebsiella pneumoniae</i>	-	+	+	-	3	6.7
<i>Salmonella typhi</i>	-	+	-	-	2	4.4
<i>Proteus vulgaris</i>	-	+	-	+	2	4.4
<i>Serratia marcescens</i>	-	-	+	-	2	4.4
<i>Micrococcus luteus</i>	+	-	+	-	2	4.4

TABLE 3: Distribution of fungal isolates in wastewater sampled from different locations

Organisms	LA	LB	LC	LD	No. of Isolates	% Occurrence
<i>Aspergillus niger</i>	+	+	+	+	10	31.3
<i>Aspergillus fumigatus</i>	+	+	+	+	7	21.9
<i>Triscelophorus monosporus</i>	+	-	+	-	5	15.6
<i>Penicillium chrysogenum</i>	-	-	+	+	4	12.5
<i>Penicillium italicium</i>	-	-	+	+	4	12.5
<i>Fusarium oxysporum</i>	+	-	-	-	2	6.2

Key: + = Present, - = Absent, LA= Isolates from location A; LB= Isolates from location B; LC= Isolates from location ; LD= Isolates from location D.

TABLE 4: Physiochemical properties of wastewater collected from restaurants in Akure

Parameters	LA	LB	LC	LD	FEPA's Effluent limit
pH	7.30±0.24 ^b	7.38±0.12 ^b	7.20±0.2 ^a	7.39±0.1 ^b	6-9
Temperature (°C)	26.8±0.34 ^a	26.8 ±0.49 ^a	26.8±0.3 ^a	26.8±0.3 ^a	≥ 40
Dissolved oxygen (mg/L)	4.90±2.0 ^b	4.60±1.7 ^{ab}	8.05±1.9 ^c	3.70±1.6 ^a	20
Total dissolved solids (mg/L)	559.1±21.3 ^a	622.0±23.3 ^a	553.2.8±21.6 ^a	635.73±13.07 ^a	2000
Salinity (mg/L)	0.54±0.21 ^a	0.60±0.0 ^{ab}	0.54±0.2 ^a	0.72±0.4 ^b	NA
Total suspended solids (mg/L)	4.78±1.5 ^b	3.67±1.1 ^a	6.64±1.8 ^c	4.41±1.2 ^b	30
BOD (mg/L)	3.00±1.3 ^a	2.40±1.2 ^a	4.40±1.1 ^b	3.01±1.5 ^a	10
Turbidity (NTU)	46.00±16 ^b	36.60±8.5 ^a	42.96±11 ^{ab}	36.92±8.8 ^a	NA
Conductivity (µs/cm)	106.2±38.7 ^{bc}	88.9±29.2 ^{ab}	108.0±39.7 ^c	81.0±30.8 ^a	NA

Values are mean±SD of replicates (n=3).

Value followed by similar alphabet along the same row are not significantly different at P= 0.05

Key:

LA: physiochemical properties of wastewater from restaurants grouped to location A

LB: physiochemical properties of wastewater from restaurants grouped to location B

LC: physiochemical properties of wastewater from restaurants grouped to location C

LD: physiochemical properties of wastewater from restaurants grouped to location D

NA= values are not available

DISCUSSION

The high bacterial and fungal loads observed in restaurants wastewater (Table 1) could be due to the general degree of hygiene of restaurants and quality of water used by the restaurants. Generally, the higher microbial load could also be as a result of food particles, vegetables and oil which are the major source of organic matter in wastewater sample. Akpor and Muchie (2011) recently reported that water containing high organic matter require high microbial load to enhance degradation of solid wastes in such water. The isolated organisms (Tables 2 and 3) could be attributed to the microbiological quality of water used in preparation of food, sanitary quality of the equipment and health status of the employee.

The high occurrence of *Staphylococcus aureus* may be due to shedding of resident *S. aureus* in human skin which may contaminate food and water during handling, processing, distribution and washing of hands after eating. Adams and Moss (2009) had earlier indicated that the principal habitat of *Staphylococci* is skin, skin gland and mucous membrane of warm blooded animal. The occurrence of coliforms from sampled wastewater in different locations could be an evidence of fecal contamination of water. Aluyi *et al.* (2006) attributed high fecal load to human activities in Udu River, Warri, Delta state, Nigeria. The earlier finding of Lateef *et al.* (2006) and Makun *et al.* (2009) revealed that these organisms are of public health importance. The presence of these organisms in wastewater disposed to the environment implies that there is need to provide proper waste disposal facilities to reduce the environmental hazards it may portend.

The pH value obtained was in line with Akpor *et al.* (2008) who reported that pH of wastewater need to remain within 6 to 9 to support the growth of organisms and nutrients removal during treatment of wastewater. The level of turbidity, biochemical oxygen demand (BOD), total suspended solids (TSS) observed indicates the quality and quantity of solid matter in wastewater that are present in suspended state. The values recorded for

physicochemical parameters in wastewaters were within permissible levels stipulated by Federal Environmental Protection Agency (FEPA, 1991). Conclusively, waste disposal facilities are grossly inadequate in Akure metropolis to provide complete evacuation of both solids and liquid wastes in restaurants; as a result of this, restaurants continued to use open space as an infinite sink for their wastes. The above study revealed the microbial load and type of organisms associated with the waste water discharged to the environment. Some of these microorganisms such as *Escherichia coli*, *Shigella dysenteriae*, *Proteus vulgaris* are of public health importance. This therefore calls for proper regulatory system and enlightenment of the public on proper disposal of wastes.

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