Int. J. Chem., Environ, Pharm. Res.
Vol.1, No.3, 88-92 (2010), Special issue
ISSN: 2229-3892
CODEN: IJCEGB

12

Seasonal Variation and Impact of Brewing Effluent on the Receiving Pond Water

C.A. Etok* and C. N. Okorie
Department of Microbiology, University of Uyo, Uyo, Akwa Ibom State, Nigeria
*E-mail: caetok@yahoo.com.

ABSTRACT
The microbiological and physicochemical attributes of brewing effluent and its impact on the receiving pond water was investigated using standard procedures. The resultant high nutrient status of the pond water (SO_4^{2-} 11.94mg/l and 10.88mg/l; PO_4^{3-}, 10.42mg/l and 8.92, NO_3^- 3.15mg/l and 2.89mg/l) for the wet and dry seasons respectively had a negative effect on the BOD and COD of the pond water. Heavy metal analysis revealed that the impacted pond had high concentrations of Fe, Zn and Pb. The effluent contributed to the total heterotrophic bacterial and fungal loads of the pond water ($2.7x10^6$ cfu/ml and $5.2x10^2$ cfu/ml) respectively. Faecal coliforms, Clostridia, Salmonellae and Shigellae were readily detected in the impacted pond water. Farming in the area and the use of the impacted water for irrigation may be of serious health risk to consumers of the contaminated farm produce due to the presence of bacterial pathogens.
Key words: Waste water, Impact, Brewery, Seasonal, Pond.

INTRODUCTION

Man's activities on the environment often result in pollution and degradation and the parody that the 'affluent' society was rapidly becoming the "effluent" society is no longer a direct corollary of developed nations. Waste is a complex mixture of different substances and objects, only some of which are intrinsically hazardous to health. Wastes include substances that have no direct use and thus transported for reprocessing, dumping and elimination by different waste management methods. Waste is said to be hazardous if it is infectious, i.e. contains viable micro-organisms which are capable of causing diseases in animals or humans [1].

In recent years, a number of environmental pollution incidents have led to a renewed drive to monitor and control the quantity and quality of liquid effluents being discharged especially by industries into municipal treatment systems, natural water course and terrestrial habitat [8]. Most of these effluents pose inestimable harm to which the microbial entity in the most adversely affected. Dallas (2004) and Barnes (2004) reported that most of these effluents are known to contain significant concentrations of inorganic and organic chemicals which affect not only normal pH values but also other physicochemical attributes of the receiving ecosystem.

In Nigeria, dumping of waste is the commonest method of disposal of municipal waste due to lack of sanitary landfill. This improper disposal of untreated solid and liquid wastes is not only harmful to human's health but constitute a threat to ecological environment (Yahang 1996). Uyo metropolis has no

Int. J. Chem., Environ, Pharm. Res.
Vol.1, No.3, 88-92(2010), Special issue

sanitary landfill and residents indulge in the rudimentary form of waste management that involves the collection and dumping of wastes in various dumpsites scattered in the city. There is currently paucity of information on the attributes of the brewery waste water which is used by famers for irrigation. Concern for human health and the environment are the most important constraint in the use of waste water. The present study therefore focuses on the characterization the effluent and its impact on the artificially created pond.

MATERIALS AND METHODS

Sampling Location

The brewery is located at Aka Offot in Industrial Estate along Uyo-Nung Udoe Road, Akwa Ibom State.

Collection of Samples

Effluents were collected with pre-sterilized 1 litre plastic container from three points namely; the point of discharge, from the factory and one point each from each of the non-concrete reservoirs that stored the effluent, sampling was carried out during the dry season (December to February) and wet season (May to September).

All samples for bacteriological and physicochemical analyses were stored in ice-packed coolers and transported to the laboratory within 8 hours of collection. The waste water was acidified with 2ml of concentrated HNO_3 per litre before storage.

Physicochemical Properties

A portion of the unacidified waste water sample was analyzed for pH using pH meter, (Kent Fil 7020 Japan) temperature, Biological Oxygen Demand (BOD), Total salinity (APHA 1981).Determination of sulphate content of waste water was carried out turbidometrically using UV visible HACH spectrophotometer wavelength 425nm [3]. Phosphate was estimated by digestion with persulphate [2]. Nitrate content effluent was determined colorimetrically by UV/visible HACH Spectrophotometer [2]. Ammonium salts was determined with HACH spectrophotometer using the Nessler method (Radojevic and Bashkin 1999).

Determination of Heavy Metals

The levels of Pb, Zn, Cu, Ni, Fe. Cr, and V were determined using the method of Kanu *et al.* [9]. Precisely, 10ml volume of effluent was dispensed into an evaporation dish and treated with 15ml of conc. $HN0_3$. The mixture was evaporated on a water bath and transferred quantitatively to 100ml standard volumetric flask and made up to volume with deionized water. Metals were determined using Atamic absorption spectrophotometry (Perkin Elmer 6001) at 325nm.

Determination of Microbial Load

Microbial load of the effluent was determined by the pour plate method after serial dilution. The total heterotrophic count was on nutrient Agar, (NA) total coliforms in MacConkey Agar, (MA) faecal coliforms in Eosin Methylene Blue, (EMB) Salmoneellae and Shigellae on SS Agar and fungi on Sabouraud's Dextrose Agar (SDA) supplemented with $5.0mg^{-1}$ streptomycin to inhibit bacteria (Essien *et al* ;2007). Clostridial load was determined on thiosulphate citrate bile salts (TCBS) agar. All the inoculated plates were incubated at 37^0c for 24hrs except TCBS which was incubated for 2days. SDA plates were incubated at room temperature for 4-7 days before enumeration.

RESULTS AND DISCUSSION

The results of the physicochemical properties of brewing effluent and the effluent impacted pond are shown on Table 1. There were no significant changes in ($p>0.05$) the parameters of the effluent during the wet and dry season. However in the effluent impacted pond, there were significant ($P<0.05$) variations in some of

Int. J. Chem., Environ, Pharm. Res.
Vol.1, No.3, 88-92(2010), Special issue

the parameters. The TDS of the pond were higher in the wet season than in the dry season. Concisely, the COD and BOD of the pond water were higher in the dry season than in the wet season. The pH of the pond water and effluent ranged from 27^{O}C to 30^{0}C.

Table 2 shows the heavy metal load of the effluent and the impacted pond. Generally, the values of the heavy metals were higher in the impacted pond than in the effluent for both seasons. Also the levels of the heavy metals were higher in the wet season than dry season.

The mean bacterial and fungal load of the effluent and impacted pond are presented on table 3. The heterotrophic bacterial counts in the effluent impacted were 2.7x10^6 cfu/ml and 3.4x10^5 cfu/ml for wet and dry seasons respectively while the total coliform counts were 3.2x10^5 cfu/ml and 8.2x10^4 cfu/ml for wet and dry seasons respectively. However, faecal coliforms, Salmonellae / Shigellae and Clostridia were not detected in the brewing effluent. Fungal load of the effluent impacted pond during the wet and dry season were 1.9x10^4cfu/ml and 2.8x10^4cfu/ml respectively.

The abundance of indicator bacteria and associated food-borne pathogenic bacteria isolated from effluent impacted pond is shown on Figure 1. The most prevalent bacteria during the wet seasons were *Bacillus* species (83.3%); *Staphylococcus aureus* (75%). While for dry seasons *Bacillus* species (66%), *S. aureus* (66%) and *Enterococcus faecalis* (58%) were prevalent.

The physicochemistry of the effluent and the impact pond shows a slight acidic pH. How pH increases the degree of ionization, speciation and precipitation of chemical pollutants, especially heavy metals. pH is therefore cultural to the activity and biodiversity of aquatic organisms because it influences the functions of virtually all enzymes, hormones and proteins Kiel (1996).

The temperature levels of the effluent impacted pond water were slightly higher during the dry season than the wet season. This may be ascribed to changes in climatic conditions especially diurnal temperature and water volume. The temperature of the pond surface water were with the **FMEUV/DPR** limit of 350^{0}C for aquatic environment but exceeded the 25.0^{0}C limit recommended by WHO for surface waters The high concentrations of nutritive salts (Phosphates and sulfates) in pond water during the wet season be due to by- products of the brewing process which serve as nutrients in the impacted pond. Chandram and Ramamouth (1984) reported a gradual increase in the nutritive salt levels of wetlands during the wet season owing to enrichment by floods.

The increase in BOD and COD values of the impacted pond especially in the wet season might be due to the increasing amounts of input of decomposable organic matter brought into the lentic water body through surface runoff, which require oxygen for their biodegradation. Similar results have been reported by Akpan (1991).

The major source of metals in the impacted pond may be the raw materials especially the fermentable carbohydrate source used for production. Plants growing in metal laden soil have been known to remove metals from the environment and accumulate them within cells [5]. Diseases associated with heavy metal toxicity are Alzheimer, anemia, lung cancer, organ dysfunction and neurological disorders (Rogers, 2000).

Although the brewing effluents do not contain faecal pollution indicators, the detection of faecal contaminants at the impacted pond may arise from active human presence (farms) in the area. Poultry manure is extensively used as additional nutrient source on *Talinum triangularae* grown on the adjoining soil. Although faecal coliforms are not usually harmful, their presence indicate the presence of faecal wastes which may contain pathogens.

Int. J. Chem., Environ, Pharm. Res.
Vol.1, No.3, 88-92 (2010), Special issue

Table-1: Seasonal variation of physiochemical attributes of Brewery effluent and effluent impacted pond.

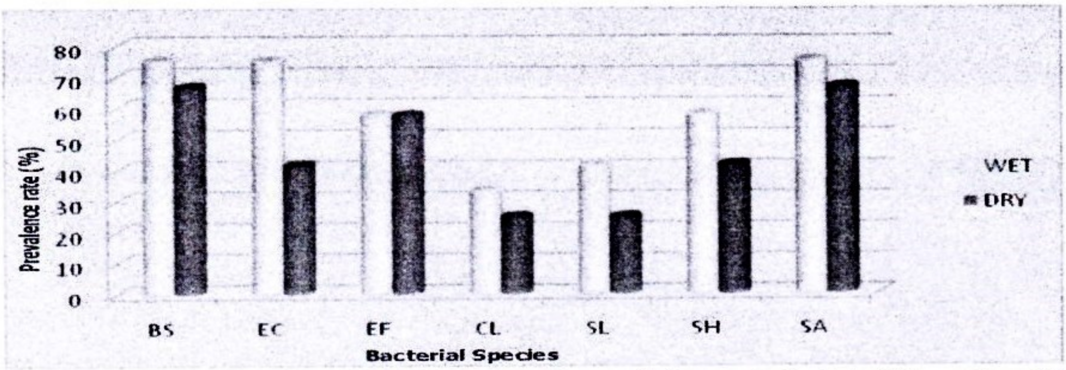
Parameter	Wet season		Dry Season	
	Effluent	Pond water	Effluent	Pond water
pH	6.81	6.68	7.1	6.12
Temperature (^{0}c)	28	27	30.11	29.5
Salinity (%)	0.05	0.11	0.51	0.21
COD (mg/l)	4.72	215.12	4.79	275.0
BOD (mg/l)	9.89	89.22	10.3	102.23
SO_4^{2-} (mg/l)	7.91	11.94	5.92	10.88
PO_4^{3-} (mg/l)	8.52	10.42	7.22	8.92
$N0_3^-$ (mg/l)	2.07	3.15	2.11	2.89
NH_4^+ (mg/l)	2.19	2.24	2.16	1.95

ble -2: Variation in Heavy Metal load of Brewing Effluent and Effluent Impacted Pond (mean values in mg/l).

Parameter	Wet season		Dry Season	
	Effluent	Pond water	Effluent	Pond water
Pb	0.27	0.58	0.20	0.50
Zn	0.41	0.24	0.12	0.60
Cu	0.12	0.17	0.12	0.59
Ni	0.01	0.03	0.01	0.02
Fe	0.76	1.36	0.76	0.59
Cd	0.12	0.30	0.12	0.30
V	0.08	0.15	0.10	0.06

Table -3: Mean microbial load (cfu/ml) of Brewing Effluent and impacted Pond (Values are means of three replicates).

Microbial Group	Wet season		Dry Season	
	Effluent	Pond water	Effluent	Pond water
Heterotrophic Bacteria	2.1x104	$2.7X10^6$	$2.5X10^4$	$3.4X10^5$
Total Coliform	$1.7X10^1$	$3.2X10^5$	$1.9 X 10^1$	$8.2X10^4$
Faecal Coliform	ND	$3.7X10^5$	ND	$2.4X10^3$
Clostridia	ND	$1.5X10^2$	ND	$2.2X10^2$
Salmonellae/Shigellae	ND	$2.0X10^2$	ND	$1.7X10^2$
Fungi	$5.2X10^2$	$1.9X10^4$	$6.8 X 10^2$	$2.8X10^4$



ig.-1: Indicator bacteria and associated food-borne pathogenic bacteria isolated from the effluent impacted ond (BS = *Bacillus Species;* EC = *Escherichia coli;* EF = *Enterococcus faecali;* CL = *Clostridium sp.;* SL = *Salmonella sp.;* SH = *Shigella sp.;* SA = *Staphylococcus aureus).*

CONCLUSION

The study has shown that the brewing effluent is laden with heavy metals namely Fe, Zn and Pb. This m be suspected to pose some health risks since the crops have the potential for metal uptake. In additio human activity may be responsible for the presence of faecal pollution indicators.

However if steps are taken to reduce the heavy metal load and human activities regulated within the effluent discharge facility, the waste water could be of immense benefit to farmers since it contains high levels of nutritive salts (Sulphates, Phosphates, nitrates, ammonium) required for plant growth.

REFERENCES

1. Agunwamba, J.C., Water Engineering System (2000)
2. APHA (American Publish Health Association) (1981). Standard method for the Examination Water and Waste Water, 15th ed. Washington D. C.
3. APHA (1998) Standard methods for Examination of Water and Waste Water (20th ed) Americ Publish Health Association.
4. Chidaunbalam, P. S., Pugazhendi, N, Lakshmanan C., Shanmagasundaram R., Journal Envir Pollution, **2** (1996) 133.
5. Cowgill, Vim., Archir for Hydrobiologic, **45** (1974) 1119.
6. Dudka, P. M., Terlak, H., Environ pollution, **94** (1996) 181.
7. Ekhaise, F. O., Anyasi, C. C., African Journal Biotechnology, **4** (2005) 1062.
8. Ikhu-Omeregbe, D. I. O, Kuipa, P. K. Hove., Water South Africa ,**31** (2005) 141.
9. Kanu, I., Achi, O. K. Ezeronye, O. U., Anyanwu E. C., International Journal of Environmen Science and Technology, **3** (2006) 95.
10. Kilani, J. S., Water South Africa, **19** (1993) 247.
11. Orhue, E. R, Osaigbove, A. U., Viviane, O. E., African Journal Biotechnology, **4** (2005) 973.

About the Authors:

Comfort Etok, received her PhD from the University of Calabar, Nigeria. She is an Associate Profes of Industrial/Environmental Microbiology and currently the Head, Department of Microbiolo University of Uyo. Her research interests include 'Bioremediation of soils polluted with crude oil, Use local emulsifiers to enhance biodegradation of crude oil by soil bacterial and Bioconversion of A wastes into animal feed supplements'. She is a member of many professional bodies and has publicati in reputable International Journals.

Chibundo Okorie*, obtained her MSc. Degree in Environmental Microbiology from the University Uyo, Nigeria. She is currently a Research Assistant with the Department of Microbiology, University Uyo. Her research interest is on 'Impact of Industrial effluents on soil and aquatic environments'. Sh a member of some professional bodies.

***Correspondence: caetok@yahoo.com**