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Impact of Effluents from Garri Processing Industries on the Environment in Bida, Niger State of Nigeria

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Abstract: Effluent and soil samples were collected from 5 different garri processing industries in Bida. Soil samples were obtained 5 m away from each discharge point. Result obtained from Efumadami discharge point showed that pH, BOD_5, COD, total solid has the highest values of 4.0, 616, 400 and 700 ppm, respectively while those from Efumayaki has the lowest values of pH, BOD_5, COD, total solid with 4.3, 513, 120 and 420 ppm, respectively. It was equally of interest to observe that most of the ions tested for in the soil samples increased as the depth of collection increased. The soil samples were observed to be seriously polluted by cyanide ion. A two-way ANOVA showed that as the depth of collection of soil samples increased, cyanide concentration also increased.

Key words: Effluents, garri, pollutant, cassava

INTRODUCTION

The threat to human and aquatic lives posed by industrial liquid and gaseous effluents cannot be over-emphasized. Industries have long been implicated in the discharge of toxicants in the environment. Over 1.2 billion of World's city dwellers breath highly polluted air, 10% of World's rivers are heavily polluted with discharges from food and allied industries and users of these rivers and streams are constantly exposed to health related risks due to this indiscriminate discharge of industrial effluents (Salami and Egwin, 1997).

Cassava (Manihot Esculenta Crantz) processing into garri involves several unit operations visa-vis, peeling, washing, grating, pressing and fermenting, sieving, roasting and drying. Traditional garri production is associated with the discharge of large amounts of water, hydrocyanic acid and organic matter in the form of peels and sieves from the pulp as waste products. When these waste products are improperly disposed, they are left in mounds which generate offensive odours and unsightly scenarios (FAO, 2004).

The major component of the effluents out from garri processing industries is cyanide and in most cases, these effluents are channeled into pits where they continue to accumulate and sink gradually into the surrounding soils thereby posing a serious health and environmental hazard.

It is therefore, intended in this research, to find out the chemical characteristics of the effluents and soil within garri processing sites as well as ascertaining level of cyanide contamination on soil and the surroundings.

MATERIALS AND METHODS

Collection of sample: Soil samples were obtained 5 m away from each discharge point. The soil samples labeled A, B and C were taken from the top soil, 50 cm depth and 1 m depth, respectively. Effluent samples were collected from pits into which they accumulate. These samples were collected from 5 different garri processing industries in Bida and the effluents were stored in clean 25 L plastic jerricans.

Conductivity and pH determination: The conductivity of the effluent was determined using a conductivity apparatus (YSI Model 34) according to Salami and Egwin (1997) while the pH of the sample was found with a pH metre (7020 HACH) following standardization with a buffer solution (Salami and Egwin, 1997).

Temperature: Temperature was determined using a thermometer (0-100°C)

Alkalinity: A 5.0 mL of sample was titrated against 0.02M HCI to pinkish end point using methyl orange indicator as described by Salami and Egwin (1997).

Total hardness: A10 cm^3 of the effluent sample was added to 2 cm^3 buffer of pH 10, followed by 2 drops of

Eriochrome Black T indicator which was thoroughly mixed. The mixture was titrated against 0.01 M ethylenediaminetetracetic acid (EDTA) until a light blue end point colour according to Salami and Egwin (1997).

Dissolve Oxygen (DO): A 250 cm^3 of the sample was mixed with 2 cm^3 each of Manganese (II) Sulphate ($MnSO_4$), alkaline iodide-azide and 1 cm^3 phospheric acid (H_3PO_4) with shaking. Total 200 cm^3 of the mixture was put into a 500 cm^3 conical flask. The liberated iodine was titrated with 0.025 M sodium thiosulphate ($Na_2S_2O_3$) solution. A 2 cm^3 of starch indicator was added and titration continued until the first disappearance of the blue colour and the dissolved oxygen was found according to Salami and Egwin (1997).

Total suspended solid: Total suspended solid was determined using gravimetric method as outlined by Salami and Egwin (1997).

Total solids: This was also carried out by gravimetric analysis using an evaporating dish as described by Ademoroti (1986).

Nitrate: Lovibond Nesseler Kit (AF 355 (43550) disc 3/24) was used for this determination. The nitricol tablet was added to the relevant compartment and colour change produced was monitored in comparison with a standard colour (WHO, 2004).

Sulphate: A 5 cm^3 conc HCI was added to 100 cm^3 effluent sample and the mixture heated to dryness and the residue was dissolved in 5 cm^3 conc. HCI while the insoluble silica was filtered and the filtrate diluted to 100 cm^3 at pH 4-5.5. On heating the filtrate to boiling with addition of barium chloride solution, a white precipitate was formed. The filtrate was digested at 80-90°C for 3 h, filtered, dried and weighed to a constant weight in a pre-weighed evaporating dish. The value of sulphate was estimated following the methods used by Salami and Egwin (1997).

Chloride: A 1 cm^3 of potassium chromate (K_2CrO_4) indicator was added to 5 cm^3 sample and titrated with 0.01M silver nitrate to a reddish end point. The titre value was used for the determination of chloride concentration (Salami and Egwin, 1997).

Sodium, potassium and calcium: Total 1000 ppm stock solution of sodium (Na), potassium (K) and calcium (Ca) were prepared. Both the standard (Na, K, Ca) and sample solutions as well as the blank solution were aspirated using a flame photometer (GallenKamp BKL-20) with the filter of Na, K and Ca in place and the readings of elements in the sample solution taken as recorded by Salami and Egwin (1997).

Cyanide: A 30 mL of the effluent sample was taken in the presence of a buffer solution, thus releasing the bound glycosidic acid. The resulting acid was distilled into 0.IN hydrochloric acid leach and after acidulation, the cyanide acid is mixed with bromine water forming bromine cyanide. When treated with pyridine and 2-aminobenzoate acid, a red colour was visible and the colour intensity was measured using a flame photometer (Ademoroti, 1996).

Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD): The chemical and biochemical oxygen demands were measured according to standard methods as described by Ademoroti (1986).

RESULTS AND DISCUSSION

Physical and chemical characteristics of cassava effluents from 5 locations of garri processing industries in Bida town are shown on Table 1.

The electrical conductivity of the 5 samples were low indicating low presence of conducting ions while the pH values showed that these effluents are acidic. World Health Organisation (WHO, 2004) admissible limit for pH value in effluent waters is 6.5-8.5 (Ademoroti, 1996). The high values of pH may be attributable to the presence of prussic acid (Gibbon and Pain, 1985) and the high values of Alkalinity. Generally, all the effluents have slightly irritating odour and this goes to explain the odious smell which normally oozes out from garri processing industry and its surrounding.

According to, Ademoroti (1996), water quality is low when its dissolved oxygen is lower than 9.2 and the suspended solid is higher than 9.2 ppm. Therefore, the effluent if untreated before discharge into the environment is a potential source of water pollution within the vicinity. Also the level of cyanide content was observed to be very high (300-600%) as against WHO (2004) admissible limit of 0.07 ppm. The highest value was obtained from the sample collected from Efumayaki followed by those of Masaga, Edogifi, Kotaworo and Efumadami. However, it should be pointed out that if the cyanide level is higher than 0.2 ppm, it will definitely cause ill-health and ultimately death (Ademoroti, 1996).

In a study by Ademoroti (1996), it was shown that there is a significant strong linear relationship between COD and BOD_5 of domester, poultry and brewery wastewaters at 95 and 99% confidence levels. BOD_5 is the amount of oxygen required by bacteria to break down to

Table 1: Physical and chemical characteristics of cassava effluents

Variable	Masaga	Efumayaki	Kotaworo	Edogifu	Efumadami	WHO (6) Standard
pH	4.5	4.3	4.3	4.1	4.0	6.5-8.5
Alkalinity (mg/IcaCO$_3$)	150.0	140	141	130	129	-
Conductivity (μs cm^{-1})	0.04×10^{-3}	0.05×10^{-3}	0.052×10^{3}	0.041×10^{-3}	0.061×10^{-3}	750.5
Temperature (°C)	21	22	21	23	25	21
Odour	Slightly irritating	Slightly irritating	Slightly irritating	Slightly irritating	Slightly irritating	-
Cyanide (ppm)	0.4	0.5	0.3	0.33	0.29	0.07
BOD$_5$ (ppm)	557	531	511	600	618	100
COD (ppm)	198	120	290	320	400	-
Dissolved oxygen (ppm)	7.0	6.0	4.5	4.63	4.2	9.2
Total solid (ppm)	483	420	512	470	700	-
Suspended solid (ppm)	221	183	210	194	315	25
Dissolved solid (ppm)	262	237	302	276	385	1000
Nitrate (ppm)	0	0	0	0	0	50
Hardness (ppm)	600	320	550	481	420	-
Colour (Hazen)	23	21	25	22	23	5

Table 2: Soil characteristics for the five zones

	Masaga soil samples						
Sample	PH	Ca^{2+}	Mg^{2+}	Na^{+}	SO$_4^{2-}$	K^{+}	Cyanide
A	5.0	3.28	6.84	0.174	0.56	0.044	0.40
B	4.5	3.44	7.20	0.201	0.78	0.052	0.60
C	3.2	3.70	7.34	2.250	0.82	0.063	0.62
Efumayaki soil samples							
A	4.4	2.94	5.54	0.20	0.52	0.0033	0.51
B	4.2	2.98	5.62	0.24	0.62	0.041	0.55
C	4.0	3.10	5.77	0.31	0.72	0.050	0.58
Kotaworo soil sample							
A	4.1	3.01	5.30	0.22	0.50	0.011	0.30
B	3.9	3.04	5.41	0.26	0.53	0.015	0.50
C	3.7	3.12	5.62	0.31	0.56	0.018	0.54
Edogifu soil sample							
A	4.1	3.04	5.12	0.180	0.52	0.042	0.34
B	3.9	3.92	5.94	0.182	0.53	0.045	0.40
C	3.5	3.82	6.00	0.185	0.57	0.050	0.42
Efumadami soil sample							
A	4.10	3.10	5.42	0.160	0.45	0.021	0.30
B	4.00	3.28	5.50	0.170	0.51	0.030	0.34
C	3.8	3.40	6.10	0.210	0.63	0.035	0.36

Sample A: Top soil; ; Sample B: 50 cm depth; Sample B: 1 m depth

simpler substances the decomposable organic matter in waste or effluent water. Therefore, the greater the decomposable matter, the greater the BOD$_5$ value (Ademoroti, 1996). The results of the study have shown high levels of micro-organisms and high values of BOD$_5$ which are 511, 531, 557, 600 and 618 ppm for Kotaworo, Efumayaki, Masaga, Edogifu and Efumadami, respectively. Also, the CODs are equally very high showing that this effluent water contain high amounts of organic matter.

In yet another study by Okafor and Egwin (2004) it was reported that treatment of cassava effluent with locally developed absorbents reduced BOD and COD upto 50 and 75%. Effluents from garri processing industries should therefore be treated with locally developed powdered adsorbents before discharge into the environment.

Table 2 shows the result of soil analysis done on the soils from the 5 sites of Masaga, Efumayaki, Kotaworo, Edogifu and Efumadami.

Calcium, magnesium, sodium and potassium ions increased as the depth of soil collection increased. From Table 2, it was equally observed that the cyanide concentration increased as you move down the soil which implies that sooner than later, underground water resources within Bida town would have been heavily polluted with cyanide. A two-way analysis of variance showed that these ions increased in concentration as you move from top soil to a depth of 1 m since F calculated is greater than the critical value of F. This will constitute a great danger to humans, animals and aquatic lives. This trend was equally confirmed by an increase in the pH values as you move down the soil.

The top soil (zone A) from Efumayaki has the highest concentration of cyanide followed by those of Masaga and Edogifu while those from Kotaworo and Efumadami contain the least. At a depth of 50 cm (zone B), Masaga sample toped all others followed by those of Efumayaki, Kotaworo, Edogifu and lastly Efumadami's sample Cs followed exactly the same trend as sample bs.

CONCLUSION

The effluent characteristics showed that some properties of the effluent exceed the World Health Organisation standard for industrial wastewaters. The cyanide contamination in both the effluent and soil samples was very enormous. This portends a grievous consequence on the underground water resources now in the immediate future. All local communities involved with garri production should be enlightened on the dangers inherent in discharging these effluents into the environment without treating them to reduce the pollutants contained in them.

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