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Impact of Food Processing Effluents on the Receiving Streams

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Abstract: This study was carried out to evaluate the impact of effluents from food processing industries on the receiving streams. Effluents from two industries were analyzed into their physical constituents to determine their conformity with national and international standards. The results of the effluents analysis showed that the physical parameters: temperature, turbidity, total solids, total dissolved solids and total suspended solids violated either Nigeria's Federal Environmental Protection Agency (FEPA) or FAO standards or both. It was concluded that industrial activities if not properly monitored and controlled normally lead to environmental pollution and degradation. In order to protect the environment from the adverse effects of food processing industries; utilization of best available technology, payment of optimal liability compensation to local communities and institutionalization of adequate abatement measures were recommended.

Key words: Evaluation, effluents, food, impact, pollution, processing, streams

INTRODUCTION

Over the past 35 years, the environmental problems experienced throughout the world have forced both developed and developing countries to question and re-assess their methods of planning and administration of their environment (Barnor, 1993). For quite sometime now the issue of development vis-à-vis environmental protection has become one knotty problem that has continued to generate heated debate, especially in developing countries. This is so because, first, environmental quality itself is part of the improvement in welfare that development attempts to bring. If however, the benefits from raising incomes offset the costs imposed on health and the quality of life by pollution, this cannot be called development. Secondly, environmental damage can undermine future productivity. Consequently, the need to evaluate the environmental impact of industries was recognized by the United Nations Environmental Programme's (UNEP's) Governing Council (GC) in 1990, which requested practical recommendations and criteria to meet this need (UNEP/GC, 1990).

Industry and in fact, industrialization is a major is a major activity promoted by governments in their development strategies to make a significant contribution to the enhancement of human welfare. Industrial operations or processes invariably involve the conversion of raw materials and resources into semi-finished and/or finished products. As the conversion can never be completely total, residuals in the form of energy and matter will be formed. If the residuals are not utilized they become waste and if discharged into the biosphere, can become pollutants (World Bank, 1978; Chukwu, 2005). The degree to which the pollutants affect the physical environment depends upon their quantitative and qualitative characteristics as well as the receiving media. This is because some pollutants are readily biodegradable, while others persist for a long time and may not even decompose. Also, some pollutants have low toxicity, whereas others are highly toxic and/or carcinogenic even in trace quantities. Therefore, as measurements, monitoring, analytical and bioassay techniques improve, the eco-toxicological effects of pollutants also become better of pollutants also become better known.

The basic issue is how industrial development can actually take place without necessarily destroying the environment. This is the import of evaluating the environmental impact of effluents from industries. It is generally agreed that processing industries have impact on the physical and socio-economic environments. What is not known is the degree of the impact and whether the impact can be assessed and evaluated before they occur, so that they can be better controlled and managed. The main objective of this study is to evaluate the impact of the effluents of 2 food processing industries and suggest mitigation measures for the attenuation of any negative impact. This was done using Nasco Foods Nigeria Limited Jos and Cadbury Nigeria Plc, Ikeja, as case studies.

MATERIALS AND METHODS

The food processing industries assessed in this study are Nasco Foods Nigeria Limited and Cadbury Nigeria Plc. They are located at No. 44 Yakubu Gowon Way, Jos, Plateau State and Lateef Jakande Road, Agidingbi, Ikeja, Lagos State, respectively. Jos is a city in the middle belt of Nigeria and capital of Plateau State. Jos is on Lat. 9° 52′ N and Long.8° 54′ E. It is located near the centre of the Jos Plateau. Jos is about 1250 m above sea level on the Delimi River. The average monthly temperatures range between 21 and 25°C. The monthly rainfall ranges from 200-325 mm between May and September and 2.5-85 mm for the months of January through April and October through December (Roder, 2004).

Ikeja is a town in the South-West of Nigeria and capital of Lagos State. Ikeja is on Lat. 6° 30′ S and Long. 3° 30′ W. It is located in Lagos Mainland. Ikeja is about 305 m, above sea level. The average monthly temperatures range between 22.3 and 32.2°C. The annual average rainfall is 1507 mm.

This study was based on Investigative Survey Research Approach (ISRA) (Anazodo, 1975; Anazodo *et al*., 1986; Chukwu, 1994). The ISRA for obtaining data entails the schedule of a series of visits to the food processing industries of interest. The tasks accomplished during such visits include inspection and witnessing of processing operations, taking relevant measurements and collection of the effluents (liquid wastes) for laboratory analysis. The sampling technique involved the removal of a small portion of the effluents that is representative of the entire effluent.

For quantitative measurements, the effluent samples used for analysis were collected in three replicates at the discharge ports. The discharge ports are cylindrical with dimensions 27.4 cm in diameter and 300 cm long, for Nasco. The Cadbury discharge ports measured 26.3 cm in diameter and 300 cm long. Effluent samples for physical parameters determination were collected in a 2 L plastic bottle. The collection was done for 10 sec. The average production days in a year for the selected industries are 200 days. The average production hours per day are 5 h. Based on the above, it was possible to quantify the effluents generated by the industries. For the determination of the physical parameters of the effluents the Association of Official Analytical Chemists (AOAC, 1980) nutritional guidelines were followed. The physical parameters of the effluents determined are temperature, pH, turbidity, conductivity, total solids, total dissolved solids, total suspended solids and oil in water.

Table 1: Quantity of Liquid Waste generated by Nasco and Cadbury Industries

Location/ site	Average discharge (hectolitres sec^{-1})	Average discharge (hectolitres hr^{-1})	Total discharge (hectolitres yr^{-1})
Nasco foods limited	0.177	637.2	637,200
Cadbury Nigeria Plc	0.163	586.85	86,800

Note: 1 hectolitre = 100 litres

Table 2: Physical Parameters of the Effluents

Parameter	$\bar{X}_N$	$\bar{X}_C$	FEPA*	FAO*
Temperature (°C)	29.00	30.60	40	25-30
pH	6.00	8.00	6-9	6-9
Turbidity (NTU)	13.20	15.00	<10	NS
Conductivity (μs cm^{-1})	0.20	0.48	NS	3.00
Total Solids (mg L^{-1})	300.00	2731	2030	NS
Total dissolved solids (mg L^{-1})	210.00	2231	2000	2000
Oil in water (ppm)	5.60	8.50	10	NS
Total Suspended Solids (mg L^{-1})	90.00	500	30	NS

NS = Not Stated; * = Maximum Allowable Level; are averages for Nasco and Cadbury industries respectively

RESULTS

The quantity of effluents generated by the 2 industries is presented in Table 1. Experimental analysis was carried out on the effluent samples and the average ($\bar{X}$) of each physical parameter is presented in Table 2 and discussed. They are compared with FEPA (1991) and FAO (1983) standards in a composite table.

DISCUSSION

Temperature: When discharged, the temperature of the effluent ranges between 29.0 and 30.6°C. This range is fairly within the recommended safe limit as expressed by FAO (25-30°C) and FEPA (40°C). A higher temperature could cause thermal pollution and adversely affect aquatic life. One of the effects of raising water temperature is that it lowers the viscosity of the water and so causes faster settling of solid particles. An increase of temperature also causes a decrease in the solubility of oxygen, which is needed for oxidation of biodegradable wastes. At the same time, the rate of oxidation is accelerated, imposing a faster oxygen demand on the smaller supply and thereby depleting the oxygen content of the water further.

Temperature also affects the lower organisms in the aquatic food chain, such as plankton and crustaceans. In general, the higher the temperature, the less desirable are the types of algae in water. In cooler waters diatoms are the predominant phytoplankton in water that is heavily eutrophic. With the same nutrient levels, green algae begin to become dominant at higher water temperatures and diatoms decline, while at the highest water temperatures, blue-green algae thrive and often develop into heavy blooms (Chukwu, 2005). Many pathogenic bacteria thrive when the temperatures of some streams are slightly increased and their abundance can be very harmful to fish. A difficulty also arises because the deleterious effects of a temperature increase on fish are synergistic with the effects of sewage, toxic chemicals, and perhaps other pollutants.

pH: The pH value of the discharged effluent was between 6.0 and 8.0. This is well within the safe limit as recommended by FAO and FEPA (6.0-9.0). Lower pH values would increase the acidity of the receiving streams, a situation that is deleterious to aquatic lives and even humans when sea foods such as oyster shell, shrimps, fish and water snails from such streams are consumed (Chukwu, 2005). Higher pH values also could encourage some sea weeds such as water hyacinth to grow and multiply. This is at present a serious concern to the Lagos State government as most seas in Lagos have been overtaken by water hyacinth. This has posed a serious threat to navigational and fishing activites.

Turbidity: Turbidity is an expression of the optical property of water that scatters light. Turbidity of the effluents was found to be between 13.20 NTU for Nasco and 15.00 NTU for Cadbury. FEPA recommended a value that is less than 10 NTU. This shows that the effluents from the two industries were in violation of the recommended level. High turbidity level leads to high level of deposition downstream and silt problems in the water where the effluent is discharged. This could cause blockage of drain passages due to deposition that could cause flooding. If the wastewater is used for irrigation, the suspended matter could block the soil pore spaces leading to poor drainage and increased runoff resulting to flooding and possible erosion problem. In addition, if such water is to be recycled, it increases the cost of water treatment.

High turbidity also adversely affects the aquatic life by preventing adequate penetration of sunlight into bodies of water. Sunlight is needed by sea weeds for photosynthetic activities. It also leads to blocking of the gills of the fishes, making the aquatic life population in the river to reduce. In addition, visibility of aquatic lives is impaired at high turbidity levels. However, decreased turbidity beyond a certain level is not good in itself. This is because decreased turbidity promotes the growth of algae and photosynthetic activities (Chukwu, 2005). Whereas this increase in photosynthesis increases the dissolved oxygen during sunlight hours, the large amount of organic material tends to reduce greatly the available dissolved oxygen during hours of darkness. Hence it can be seen that merely reducing turbidity does not necessarily solve problems, but may create a new one.

Conductivity: The conductivity of the effluent ranges between 0.20 and 0.48 μs cm^{-1}. This is well within the limit of 3.0 μs cm^{-1}. recommended by FAO for water used for agricultural purposes, e.g. irrigation. One of the important criteria usually used to assess the irrigation water quality is total concentration of dissolved solids/salts. It is expressed in terms of electrical conductivity (EC).

Total solids: The Total Solids (TS) of the effluent represent its dry matter content. It is the aggregate sum of the total dissolved solids and the total suspended solids in the effluent. The TS of the effluent from Cadbury which is 2731mg L^{-1} violate the permissible limit set by FEPA. Total solids contribute to high turbidity of water bodies into which they are discharged. The effects of turbidity have earlier been discussed. They also lead to siltation, thereby reducing navigational activities of fishermen. The effect of total solids reflects in the loss of benthic organisms which in most cases are endangered and rare species. When the effluent is evaporated to dryness, the total solids can serve as a source of organic fertilizer.

Total dissolved solids: The Total Dissolved Solids (TDS) range between 210.00 mg L^{-1}. for Nasco and 2231 m L^{-1} for Cadbury. The TDS for Cadbury was well above the recommended value of 2000 mg L^{-1} by FEPA and FAO while that for Nasco was far below the recommended value. Each has its own implication. TDS is a general indicator of water contamination. A low level is supposed to be an indication of relatively clean water. This is however not the case. A low value of TDS implies that the sediments are of smaller size. This is more dangerous because the sediments could easily hamper respiration of sea animals by blocking the respiratory pores. This calls for a proper sedimentation process if the quality of the wastewater is to be improved since smaller sediments settle more slowly than bigger ones. A high value of TDS leads to nutrient enrichment or eutrophication (Chukwu, 2005).

Total suspended solids: In general, suspended load may be considered a pollutant when it exceeds natural concentrations and has a detrimental effect on water quality in its biologic and aesthetic sense. The total suspended solids for the effluents from Nasco and Cadbury which are 90 and 500 mg L^{-1}. both violate the FEPA's permissible limit of 30 mg L^{-1}. In their present concentration they could contribute to high turbidity of the receiving waterbody. Increase in turbidity can be considered a type of pollution in that it affects the biotic balance. Turbidity increases with, but not as fast as, suspended-load concentration (Emmet, 1975).

Oil in water: The oil level of the liquid waste is between 5.60 and 8.50 ppm and this is less than the recommended upper limit of 10 ppm by FEPA. Consequently, the discharged effluent is not expected to have surface aeration problem. A high level of oil in surrounding bodies of water can lead to physical damage of the respiratory organs and suffocation of aquatic organisms during the struggle to get oxygen for respiration.

CONCLUSION AND RECOMMENDATIONS

This study was carried out to analyze the effluents from Nasco Foods Nigeria Limited and Cadbury Nigeria Plc to determine their conformity with standards set by national and international regulatory agencies (FEPA and FAO). The analysis of the effluents revealed that in their form, the effluents from the industries failed to satisfy laid down standards of effluent composition of temperature, turbidity, total solids, total dissolved solids and total suspended solids. This implies that the effluents have the potential of impairing adequate penetration of sunlight, and to cause damage to the gills of fish in the river where it is discharged.

Since, the effluent level of violation of set standards is significant enough to be of concern to environmental protection agencies, a better disposal method than the present is advocated. In order to protect the environment from the adverse effects of food processing industries, a number of mitigation measures and management options that should be implemented are utilization of the Best Available Technology (BAT), payment of optimal liability compensation to local communities and institutionalization of adequate abatement measures.

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