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EFFICIENCY OF THE DECOMPOSITION PROCESS OF *AGARICUS BISPORUS* IN THE MYCOREMEDIATION OF REFINERY WASTEWATER: ROMI STREAM CASE STUDY

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ABSTRACT

This study involves the use of the decomposition of *Agaricus bisporus* in the mycoremediation of refinery waste water. Kaduna Refining and Petrochemical Company release its waste water into Romi stream which is affecting the quality of the stream water and it Biota. Several technologies have been employed to treat this water but all to no avail. Mycology which is an emerging technique in the treatment of waste water was employed in this study owing to the fact that the decomposition of this organism is associated with bacteria's that have the potentials of degrading pollutants. This study recorded increase in pH and Dissolved Oxygen (DO) but recorded high reduction efficiency for Sulphate, Phosphate, Nitrate, Alkalinity, Electrical Conductivity (EC), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and heavy metals (Manganese (Mn), Silver (Ag), Lead (Pb), Mercury (Hg) and Zinc (Zn). These studies thereby show that the decomposition process of *Agaricus bisporus* is effective in the remediation of wastewater from Kaduna Refining and Petrochemical Company.

KEYWORDS: Wastewater, Remediation, Fungi, Refinery wastewater, Flora and Fauna.

INTRODUCTION

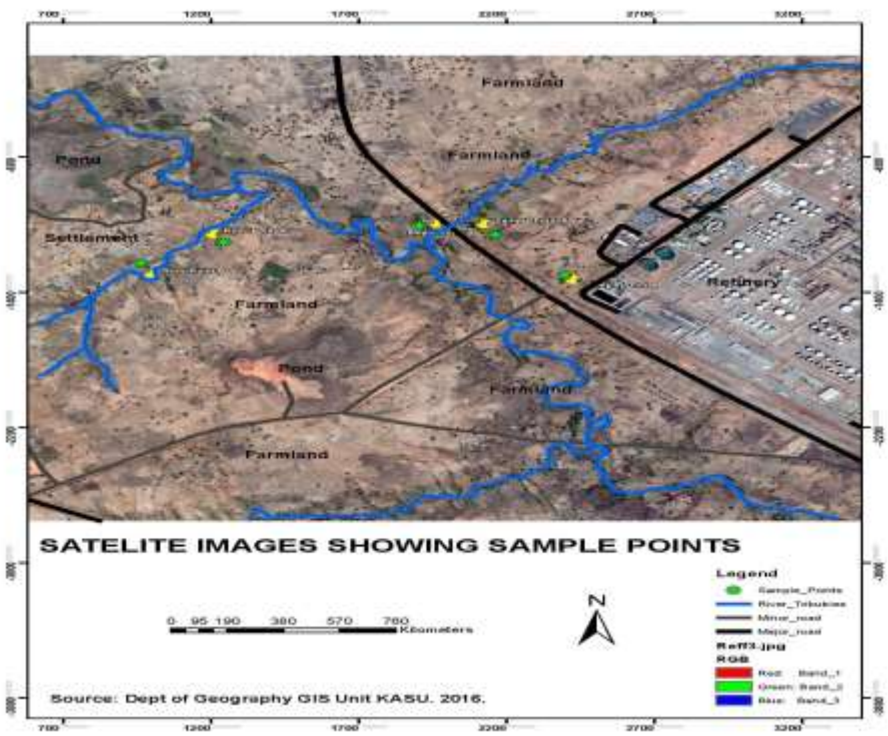
The world's ever increasing population and her progressive adoption of an industrial- based lifestyle has inevitably led to an increased anthropogenic impact on the biosphere (Asamudo *et al*., 2005; Aliyu *et al*., 2016). Since the beginning of the industrial revolution, water pollution by toxic metals has accelerated dramatically. According to Nriagu (1996) about 90% of the anthropogenic emissions of heavy metals have occurred since 1900 AD; it is now well recognized that human activities lead to a substantial accumulation of heavy metals in water on a global scale. Man's exposure to heavy metals comes from industrial activities like mining, smelting, refining and manufacturing processes (Nriagu, 1996). A number of chemicals, heavy metals and other industries in the coastal areas have resulted in significant discharge of industrial effluents into the coastal water bodies. These toxic substances are released into the environment and contribute to a variety of toxic effects on living organisms in food chain (Dembitsky, 2003) by bioaccumulation and biomagnification. Heavy metals, such as cadmium, copper, lead; chromium, zinc and nickel are important environmental pollutants, particularly in areas with high anthropogenic pressure (United States Environmental Protection Agency, 1997). Water bodies has been traditionally the site for disposal for most of the heavy metal wastes which needs to be treated (Bio-Wise, 2003; Aboulroos *et al*., 2006). In refining of refinery products opportunities exist for the release of other pollutants such as oil and grease, phenol, sulphate, suspended solids, dissolved solids, nitrates, e.t.c (Asamudo *et al*., 2005; Nayyef and Amal, 2012; Ji *et al*., 2007; Patel and Kanungo, 2010) in to the ecosystem. These pollutants are produce in an effort to improve human standard of living but ironically their unplanned intrusion into the environment can reverse the same standard of living by impacting negatively on the environment (Asamudo *et al*., 2005; Subhashini *et al*., 2013; Xiaomei *et al.*, 2004). Refinery effluents can seep into aquifers and pollutes the underground water or where it is discharge without proper treatment into water bodies, the pollutants cannot be confined within specific boundries (Nayyef and Amal, 2012; Asamudo *et al*., 2005). They can therefore affect aquatic lifes in enormous ways (Ugya and Ahmad, 2016).

Many technologies have been developed to treat this waste water and restore environmental quality; However their costs are high and most of them are difficult to use under field conditions, hence in such a condition there is an urgent need to study natural, simple, and cost-effective techniques for control of pollution from industrial effluents (Ji *et al*., 2007). Viewing this fact mycoremediation was assumed to be very useful, as it is an innovative, eco-friendly and efficient technology in which natural properties of fungi are used in engineered system to remediate hazardous wastes water (Ugya *et al*., 2016). The present study thereby shows the efficiency of the decomposition process of *Agaricus bisporus* in the remediation of refinery waste water from Kaduna Refinery and Petrochemical Company, since the waste water has become a menance to the flora and fauna of Romi.

MATERIAL AND METHOD

The Study Area

Romi stream is one of the tributary of River Kaduna; it is located in the southern part of Kaduna metropolis between latitude 10° to 11° north and longitude 7° to 8°East, River Romi follow a course of about 16.4 km and also receives waste water from Kaduna Refining and Petrochemical Company.



Collection of Samples

Sampling Points

Water samples were collected in five different points (point A, point B, point C, point D and point E); The point E samples were collected at about 14 km away from the point of discharge of the refinery effluents into the Romi stream, while the point A samples were point of discharge of the refinery effluents into the stream. The point B samples were collected at about 4 km away from the point of discharge of the refinery effluents into the stream. The point C and D samples were collected at about 8km and 10km respectively away from the point of discharge of the refinery effluents into the stream. Water samples were collected using Grab method according to APHA (1998); Samples were collected into clean one litre plastic bottles and stored in an ice box of 4ºC and was taken to the KEPA and KRPC laboratory within twenty-four hours for analysis. Water samples was collected by lowering pre cleaned plastic bottles into the bottom of the water body, 30 cm deep and allowed to over flow before withdrawing. Water samples were collected from March to October, 2016.

Heavy Metal Determination in water before Treatment

Heavy metals in water samples were determined by Atomic Absorption Spectroscopy method (AAS). According to the procedure, 10ml of HNO_3 (Nitric acid) was diluted with 500ml of distilled water. The Atomic Absorption spectrophotometer had already been calculated according to wavelength of different heavy metal parameter. An aliquot of the stock solution was used as blank by aspirating for 5minutes to enable flushing of burner system and to auto-zero the instrument before measurement.

Experimental Set-up

Experiments were set up to investigate mycoremediatory efficiency by the decomposition of *Agaricus bisporus* in water collected from various points of Romi stream.

The experiments were conducted for 21 days and repeated for the period of 8 month (March-October, 2016).

Experinmental Setup

To access the mycoremediation capacity of *Agaricus bisporus* in the removal of heavy metals from refinery waste water, an offsite culture experiment was conducted in General Biology laboratory of Kaduna State University (KASU).

The experiment was grouped into five Set, each set consist of troughs each containing five liters of waste water from each station , the experiments in each group was divided into three sets.

Set 1: *Agaricus bisporus* was inoculated in waste water of different concentration 100% Water from point A

Set 2: *Agaricus bisporus* was inoculated in waste water of different concentration 100% Water from point B

Set 3: *Agaricus bisporus* was inoculated in waste water of different concentration 100% Water from point C

Set 4: *Agaricus bisporus* was inoculated in waste water of different concentration 100% Water from point D

Set 5: *Agaricus bisporus* was inoculated in waste water of different concentration 100% Water from point E.

Control: 100% water without *Agaricus bisporus* (control) (Ugya *et al*., 2015a;).

After 21 days the water samples were then filtered and heavy metal and physicochemical parameters analysis was performed on the water sample using the techniques employed by Ugya and Imam (2015) and Ugya *et al.*, (2015b).

Reduction Percentage

The pollutant removal efficiency of the decomposition process of *Agaricus bisporus* was determined as reduction percentage. The initial and final concentrations of the physiochemical parameters of water were use in the following formula:

$$\text{Reduction Percentage} = \frac{B-A}{B} \text{ X } \frac{100}{1}$$

Where A= initial concentration

B= final concentration (APHA 2005; Ugya, 2015)

RESULT AND DISCUSSION

Result obtain in this studies shows that EC, BOD, COD where significantly reduced Fig (4) while the pH was increased from 6.78 – 7.32 across the points. The increase in pH shows that the decomposition of mushroom has aided the conversion of acidic water to neutral water. Similar results were reported using different organism as performed in work by researchers such as Dipu *et al*., (2011) Ji *et al*., (2014), Wang *et al*., (2015), Ugya *et al*., (2015c), Ugya *et al*., (2015d), Xu *et al*., (2015). The high EC, BOD and COD reduction could be attributed to the degradation of pollutants by the decomposition process of *Agaricus bisporus* which result in the reduction of dissolved CO_2 (Ajayan *et al*., 2015; Fernandez *et al.*, 2016).

The high phosphorus, sulphate, nitrate and alkaline Fig (5) reduction of the waste water could be attributed to the use of this nutrient by the microorganisms responsible for the decomposition of the *Agaricus bispous*. Ajayan *et al* (2015) phosphate is used in microorganism cells mainly for production of phospholipids, adenosine triphosphates (ATP) and nucleic acid. Hence these nutrients must have been used by the microorganisms responsible for the decomposition of mushroom for growth. Similar results have be reported by Pavasant *et al.*, (2007), Khalaf, (2008), Ertugrul *et al* (2008), Chu *et al* (2009), Cheriaa *et al* (2009), Zhou *et al.*, (2014), Fernandez *et al*., (2016), Wang *et al*., (2016) using order organisms.

The high heavy metal (Mn, Ag, Hg, Pb and Zn) Fig (3) removal could be associated with the degradatory role associated with microorganisms responsible for the process of decomposition of Mushroom (Bhaita 2011). Microorganism are useful in the bioremediation of metal contaminated sites due to their ability to tolerate those metals (Malik 2004) and their small cell size; microorganism exhibit a large surface area-to-volume ratio, which is promptly available for contact with the surrounding environment; and their functionally rich cell wall groups can easily interact with cations in solution (Roy *et al.* 1993). They can also secrete enzymes that will degrade heavy metals effectively (Ueshima *et al.*, 2008; Wu et al., 2011; Prandini *et al.*, 2016; Ugya *et al.*, 2016a; Ugya and Imam., 2016).

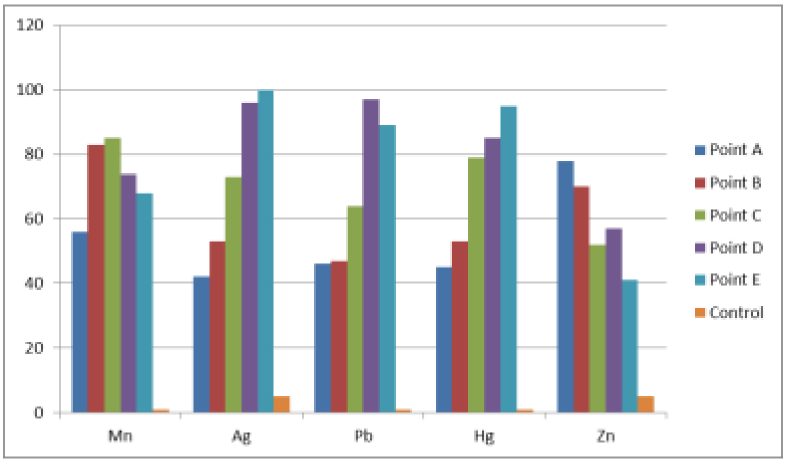


Figure 3: Mean % Reduction Percentage of heavy metals

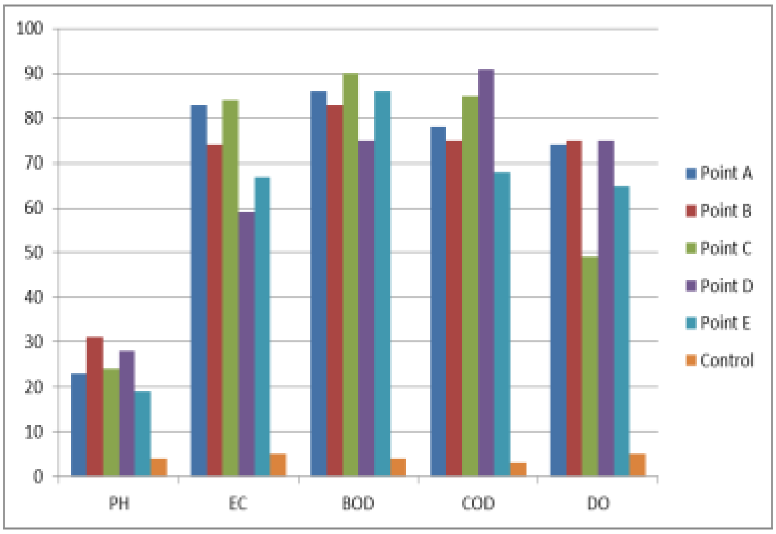


Figure 4: Mean Physico-chemical Parameter Removal Efficiency

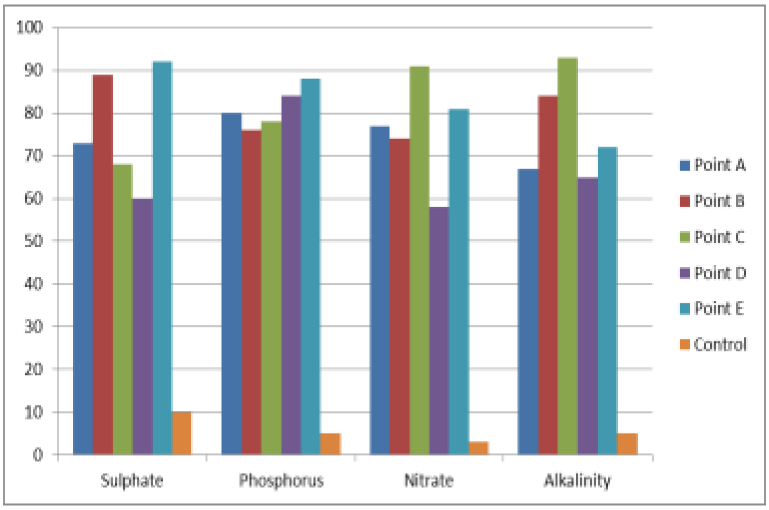


Figure 5: Mean Nutrient Removal efficiency

CONCLUSION

Water quality study of Romi Stream has brought to the fore some important concerns that were muted by research works Like Suzy *et al.,* (2016), which indicated the presence of several heavy metals in high concentration to cause contamination to biotic species of flora and fauna that, abound in the stream. Other parameters monitored such as the oxygen characteristics of the water in terms of COD, BOD and DO, Sulphate, Nitrate, Phosphorus are all indicating toxicity above the threshold that can be purified by the stream. These studies shows that efficiency of the decomposition process of *Agaricus bisporus* in the treatment of the Kaduna Refinery waste water there by reducing the toxicity on the flora and fauna since it is able to remove and degrade pollutants present in the stream to a significant level in all point.

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