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Full Length Research Paper

A mathematical approach for describing the dependence between organic matter content and pH value in some waste water

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Water pollution is a major problem in the world, which can turn our precious earth into abyss. Waste water contains so many pollutants like inorganic and organic matter. Waste water decreases the pH of water. Pollution has high organic matter per-cent, with neutral pH and low salinity. We aimed to explain such a problem mathematically using an exponential method, which can be used to eliminate pollution from earth.

Key words: Thermophilic fungi, heavy metals, organic matter (X) pH in water analysis (Y), mathematic modeling.

INTRODUCTION

Waste water is enriched with organic and inorganic substances, including heavy metals from domestic areas (Kamaludeen et al., 2003). Rapid industrialization and urbanization all over the country has led to regional and global redistribution of metals with consequent environmental pollution. Organic matter is used as a growth substrate for fungi (Mehra and Jaitly 2003; Kacpizak et al., 2005). Dissolved organic matter is highly heterogenous in nature and ranges from less than 500 to more than 5000Da in molecular weight (Imai et al., 2002).
Microbial population is mostly heterotrophic which grows on and affects solid and liquid waste. Generic composition and size are different for mycoflora. Physical and chemical characteristics vary with environmental condition for mycoflora (Jaitly, 1982). They produce enzymes for the decay of waste/pollutants.

pH and temperature are major abiotic factors which affect fungal growth, development and activity. The term “thermophilic” denotes their affinity for high temperature. That means that organisms can grow optimally above 45°C.They are very few and have been divided into two mains categories: true thermopiles and thermotolerants (Cooney and Emerson, 1964).

One of the prerequisites for a more complete control and exploitation of these fungi is temperature, which is the most important variable in their environment. Fungi are also used as adsorbent/absorbents to remove heavy metals from municipal, sewage (Goomes et al., 1998) and industrial waste water (Kamaludeen et al., 2003). Heavy metals can interact with microbial cells and there are reports that they accumulate these substances as a result of some physico-chemical mechanism and transport systems, depending directly and indirectly on metabolism of the microbes.

MATERIALS AND METHODOLOGY

Waste water samples were aseptically collected in sterilized bottles from different collecting sites of Bareilly City-Uttar Pradesh (India) listed below:
Pond water sites: Bansinagla, Gosi-gotiya, Madinath -1, Madinath-2, Pashupatinath

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Municipal sites: ADM compound, Chaupla, Civil lines, Madinath, Mission hospital
Sewage sites: Qila, Nakatiya, Sanjay Nagar.

The above sites are around the Bareilly City from U.P. (India). These water bodies' temperature was analyzed at the collection time (6:00am - 8:00am) by thermometer and their pH by systronic µ pH meter 361. Percent of organic matter was analyzed by Walkey and Black's method (1947), using the following formula:

$$X\ (\%) = \frac{6.791}{w}\left(1-\frac{T_1}{T_2}\right), \text{ for every T1 and T2, W} \neq 0$$

Where, X% is organic matter percentage, T_1 is titration reading, T_2 is Blank reading.

Salinity percentage was calculated by the following formula:

$$\text{Salinity } (\%) = \frac{W2-W}{W1-W}x100, \text{ here W1 can never be equal to W}$$

Where 'W' is pre weighted Petri plate, 'W1' is the weight of water and the Petri plate, 'W2' is the weight of the Petri plate after evaporation of the water sample at 80^0C (24 hrs).
Direct and indirect method (Warcup 1950) was used for isolation of thermophilic fungi using YPSs (Yeast Extract Soluble Starch) medium at pH 7.0. Three replicates were taken for each sample. Petriplates were incubated at 40^0C. After appearing in fungal forms, they were isolated and maintained on agar medium slants in the pure forms at 4^0C. Colonies were identified using microscope and available literature. Fungi use the organic matter as nutrient. Frequency of fungi shows presence of organic matter in water/soil/waste substances.
Now, we would use a mathematical relation for the pH and organic matter.

Mathematically: Let us assume a differential equation:

$$\frac{dy}{dx} + y = 0 \qquad \ldots (1)$$

Initially, we will take $y_o = 7$,

Because at pH=7 water is neutral, that is useful for drinking.

$$\frac{dy}{dx} + y = 0$$
$$then:$$
$$\frac{dy}{y} = -dx,$$
$$\Rightarrow \ln y = -x + \ln c$$
$$\Rightarrow \ln y = \ln e^{-x} + \ln c$$
$$\Rightarrow y = ce^{-x}, \text{But when x} = 0, \text{y} = 7 \text{ so c} = 7,$$
$$\Rightarrow y = 7e^{-x} \ldots (2)$$

Where y denotes the pH value and x denotes the organic matter.

Practically: We analyzed all the samples for different environmental parameters.

The measured pH value showed extreme alkaline. The range of pH for municipal waste water was 7.5 to 8.9; for sewage, 7.9 to 8.9; for pond water sites, 7.6 to 8.3. The pH value is less in pond water site compared to municipal and sewage sites, indicating a more alkaline nature. The pH is also temperature dependent (Goswami and Sharma, 2007). The overall temperature in the three sites ranged from 9.08 to 33.4°C at the time of sample collection between 6:00AM to 8:00AM.

Organic matter in waste water body decreased with increase of the pH value. It depends on the kinds of solved organic mater from the waste. The organic matter percentage was the highest in the municipal site (0.380 to 2.92%, Table 2), sewage (0.371 to 2.801%, Table 3) and pond water site (0.162 to 2.301%, Table 1). The trend of the total number of fungal colonies was: Municipal sites > Sewage sites > pond water sites.

Highest salinity was noted in the sewage site (10.8%) in June (Table 3). Isolated total number of colonies follows the pH value and organic matter percentage. Better growth (number of colonies) was found if the pH values were low (about neutral) and the organic matter, high. It is clear that fugal populations used organic matter from waste water as nutrient

RESULTS AND DISCUSSION

Here, in Equation 2, if we increase the value of x then y decreases (Table 4). It is known as exponential decay (Figure 1).

As seen in the above presented data (Table 4 and Figure 1), if the value of x (organic matter) increases Y exponentially decreases**.**

If initially we put x = 0, y = 7, that means that there is no organic matter found in water; and if the pH=7, then mathematically we can say that the water is useful for drinking and free of pollution. If X is greater than 0,y will be less than 7 and so on. In this case, water will be acidic and not useful for drinking. If x goes to infinity, then, from equation (2), y must be 0, which is not practically possible; but mathematically we can say the water is now highly polluted.

Conclusion

Finally, we would like to say that, in the above theory, if we increase organic matter (x), then pH value of the water decreases exponentially (only in analyzed water sites, not in all – depending on the kind of organic charge).

That means if X increases in a very low quantity, Y decreases very high. If we are trying to decrease the organic mater from the water, then we can save it for drinking, being free of pollution. Otherwise, some day there will be no drinking water and the major problem for life will come easily, for it is well known that life without water is impossible. Pollution will cause destructive lives.

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Table 1. Environmental parameters of Pond Sites in Year-2007.

Collection site	Month	March	June	Sept	Dec
	Temperature (°C)	25.5	32.0	30.9	10.10
	pH	8.1	8.0	8.3	8.0
Madinath 1	OM (%)	0.801	1.018	0.317	0.981
	Salinity (%)	6.6	7.9	4.6	7.3
	TNF	172	210	201	105
	Temperature (°C)	28.6	32.0	28.0	9.90
	pH	8.0	8.0	7.9	8.2
Madinath 2	OM (%)	1.162	2.232	2.301	1.10
	Salinity (%)	6.3	5.1	5.9	4.9
	TNF	108	124	130	92
	Temperature (°C)	28.6	32.9	29.0	9.9
	pH	7.9	8.1	8.2	7.9
Gosi-gotiya	OM (%)	1.331	0.805	2.11	1.05
	Salinity (%)	6.8	4.1	6.0	7.7
	TNF	102	102	109	96
	Temperature (°C)	26.3	32.4	29.0	9.8
	pH	7.9	8.2	8.5	8.0
Bansinagla	OM (%)	1.301	1.45	0.90	1.673
	Salinity (%)	3.6	4.2	2.0	3.0
	TNF	147	146	105	167
	Temperature (°C)	25.0	33.3	29.0	10.1
	pH	8.2	8.3	8.2	7.6
Pashupatinath temple	OM (%)	0.301	0.219	2.613	0.740
	Salinity (%)	2.8	5.8	3.6	2.1
	TNF	107	96	122	99

TNF = Total number of fungal colonies, OM% = organic matter percentage.

Table 2. Environmental parameters of municipal water in Year-2007.

Collection site	Month	March	June	September	December
	Temperature (°C)	25.5	32.0	30.9	10.1
	pH	8.1	7.8	8.3	8.6
Chaupula	OM (%)	0.901	1.018	1.117	0.981
	Salinity (%)	3.6	3.9	2.0	2.8
	TNF	105	101	240	102
	Temperature (°C)	25.3	31.0	30.5	10.8
	pH	7.8	8.0	8.0	8.3
City Station	OM (%)	2.95	1.17	2.92	1.81
	Salinity (%)	3.0	4.0	2.0	4.5
	TNF	196	87	115	94
	Temperature (°C)	25.3	31.4	29.0	9.6
	pH	7.6	8.3	8.1	7.8
Madinath	OM (%)	0.464	0.319	1207	0.964
	Salinity (%)	6.6	7.1	5.0	6.0
	TNF	208	108	73	128

Table 2. Cont.

Mission	Temperature (°C)	25.8	32.7	29.0	10.0
	pH	8.6	8.5	8.2	8.9
	OM (%)	0.763	0.971	0.509	0.380
	Salinity (%)	2.0	4.9	1.3	1.6
	TNF	93	102	97	59
ADM compound	Temperature (°C)	26.1	32.1	30.1	9.7
	pH	8.4	7.9	7.5	8.0
	OM (%)	1.543	1.073	1.46	1.001
	Salinity (%)	5.4	6.8	5.0	6.7
	TNF	109	205	219	160

TNF=Total number of fungal colonies, OM%= organic matter percentage

Table 3. Environmental parameters of sewage sites in Year-2007.

Collection site	Month	March	June	September	December
Qila	Temperature (°C)	30.0	32.0	31.9	11.0
	pH	8.2	8.0	7.9	8.2
	OM (%)	0.381	1.99	2.801	0.610
	Salinity (%)	9.2	8.1	7.0	6.8
	TNF	207	208	220	179
Nakatiya	Temperature (°C)	28.4	33.4	31.0	10.8
	pH	8.3	8.5	8.2	8.9
	OM (%)	0.747	1.071	0.447	0.689
	Salinity (%)	6.4	9.8	8.4	9.0
	TNF	197	202	96	84
Sanjay Nagar	Temperature (°C)	28.2	33.0	30.8	11.1
	pH	8.1	8.6	7.9	8.0
	OM (%)	1.584	0.901	1.876	0.317
	Salinity (%)	6.5	3.0	7.3	9.3
	TNF	190	182	198	157

TNF = Total number of fungal colonies, OM% = organic matter percentage.

Table 4. Organic matter.

S/N	Organic matter (x)	y=7 Exp(-x)
1	0	1 x 7=7
2	1	0.370 x 7=2.59
3	2	0.137 x 7=0.959
4	3	0.0508 x 7=0.3556

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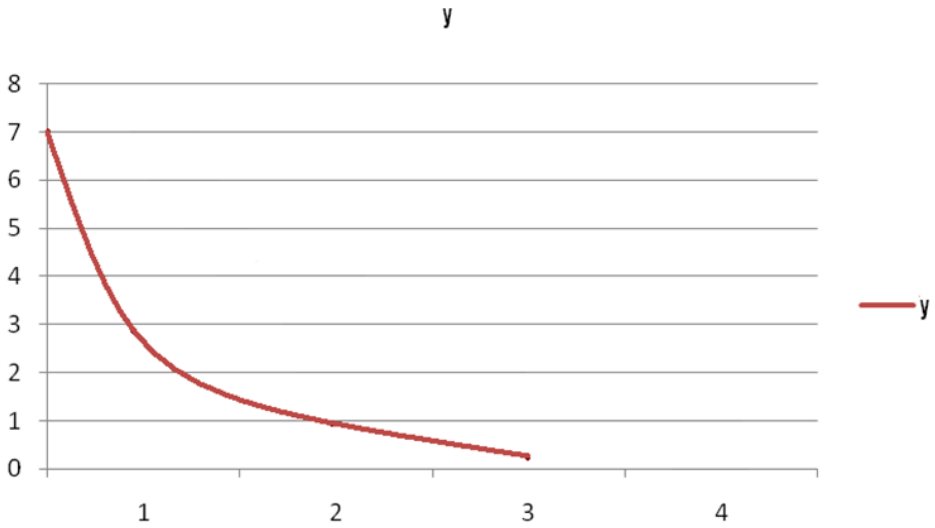

Figure 1. The relation between pH and organic matter.

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