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EXPERIMENTAL STUDY ON THE EFFECT OF IRON AND STEEL FACTORIES ON NILE PHYTOPLANKTON. COMMUNITIES & SPECIES COMPOSITION

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Key words: Iron and Steel factories west; Nile Phytoplankton Industrial west.

ABSTRACT

Short-term bioassay experiment (120-h) was carried out to determine the effect of industrial wastes of Iron and Steel Factories (waste A and waste B) on standing crop, species composition and chlorophyll a of phytoplankton at zero time and during 5 days. The results revealed that Waste A increased phytoplankton standing crop and chlorophyll a at concentrations (20,40 and 60%) while it decreased them at high concentrations (80-and100 %) while Waste B decreased them at all concentrations. The most tolerant Class was Bacillariophyceae while the most sensitive Class was Chlorophyceae. There are some species which considered to be indicator for pollution namely ***Nitschia palea*** *(Bacillariophyceae) and* ***Chrorococcus minutus*** *(Cyanophyceae). Waste A was accompanied with high concentrations of nutrients (Nitrogen and phosphorus). Heavy metals concentrations and pH values were much higher in waste B. Waste B had an inhibitory effect on phytoplankton more than waste A.*

MATERIAL AND METHOD

Experimental Bioassay: -

Bioassay experiment was conducted to determine the effect of the industrial waste of Iron and Steel Factories on phytoplankton standing crop, class & species composition, and Chlorophyll *a* concentrations.

The control:

Water sample was collected from the River Nile (up stream before the discharging point of Iron and Steel Factories).

Industrial waste:

The industrial waste samples were collected from inside the Iron and Steel Factories from two sites. The first was waste A was produced from the washing of rocks containing Iron metal. The second was waste B, which is collected from a small lake, lies inside the factories and all the wastes of the factories were poured in it. The two wastes (A & B) were kept in plastic bottles and experiment was started in the same day that the wastes were collected.

Physico-chemical analysis:

Physico-chemical analyses were carried out on the control and the two industrial wastes in the first day of the experiment (Zero time) and at the end of it (After 5 days). The physico-chemical parameters were: Air&water temperature, pH (measured every day), alkalinity, NH_4-N, NO_2-N, NO_3-N, PO_4-P, D.O.P and silicate were measured at the end of the experiment. All the parameters were measured according to A.P.H.A. (1995).

The Atomic Absorption Spectrophotometer (Model Perkin-Elmer 3010) equipped by Graphite Furnace (Model HG 600) as well as Hydride unite (Model HG 20) were used to analyze the Heavy metals (Fe, Zn, Mn, Cd, Pb, Co, Cu, and Sr) for control and the two wastes A.P.H.A. (1992).

And Fs, R_b/R_a , and acid ratios are functions of the combination of photo multiplier color filters.

Calculation of Ec_{50}:

Ec_{50} express the minimum effluent concentrations inhibiting the algal growth by 50%. Ec_{50} was calculated by using linear regression (Snedecor and Cochran, 1980).

RESULTS

The chemical parameters of control, waste A and waste B at zero time and in the end of the experiment (after 5 days) are given in Table (1), while the concentrations of Heavy metals in Control and Wastes A & B at zero time are given in Table (2).

Values of pH at different concentrations of Waste A & B during the period of experiment are shown in Table (3) and Fig. (1). In control, the pH increased gradually from its minimum value of 8.14 at zero time to its maximum value of 8.36 after 3 days. In Waste A, the values of pH increased gradually in 20%, 40%, and 60% concentrations from its minimum values at zero time to its maximum values after 4 days, then the pH values slightly decreased after 5 days except at 20% waste concentration, while in 80% the pH increased after 1 day then slightly decreased after 2 and 3 days, after that it increased again after 4 and 5 days. In 100% waste A, the pH increased after 1 day, then slightly decreased until its minimum value after 5 days. The maximum pH value in waste A was 8.51 recorded in 20% Waste concentration after 4 and 5 days, while the minimum value of 7.84 was recorded in 100% waste A concentration after 5 days.

In waste B, the pH values increased with increasing waste concentration. The maximum pH values in all Waste B concentrations found at zero time, then decreased gradually to its minimum values after 5 days in 60%, 80% and 100% waste B concentrations The maximum pH value of 11.23 waste B was recorded in 100% waste concentration at zero time, while the minimum value of 8.15 was recorded in 80% waste B concentration after 5 days.

Effect of Industrial Waste on Phytoplankton standing crop:

The effect of different concentrations of Wastes A and B on the population density of phytoplankton at zero time and after 5 days are given in Table (4) and Figure (2). In waste A. A sharply increase in total phytoplankton numbers from zero time to after 5 days in all waste A concentrations until it reached its maximum number of 3077 x 10^4 cell L^{-1} in 60% waste A concentration after 5 days. In waste B, phytoplankton numbers increased from zero time to 5 days in 20% and 40% waste B concentrations, while it decreased in 60%, 80% and 100% until it completely disappeared in 100% waste B concentration.

Effect of Industrial Waste on Phytoplankton class composition and Leading species:

Population densities of classes composition and percentage abundance to total phytoplankton are given in Table (5), While the effect of different concentrations of waste A and waste B on the population densities of the leading species at zero time and after 5 days are given in Table (6) & (7).

Bacillariophyceae was the dominant class at zero time formed more than 50% of total phytoplankton at all waste concentrations at zero time and it was the only class found in 100% waste concentration, while it formed 45.6% of total phytoplankton in control at zero time. After 5 days, the thepercentage of diatoms to total phytoplankton was decreased in control and all waste A concentrations except in 80% and 100% waste A concentrations. Also it decreased in all waste B concentrations except in 60% and 80% waste B concentrations.

The most dominant species of diatoms was *Nitzschia palea* which the only species found in 100% waste A concentration after 5 days and rise from 3 x 10^4 cell L^{-1} at zero time to 1369 x 10^4 cell L^{-1} after 5 days. The percentage abundance to total phytoplankton of Chlorophyceae was slightly decreased from zero time to 5 days in control and all waste A concentrations except in 80% waste A concentration, while it increased in all waste B concentrations after 5 days except in 60% waste B concentration.

The leading species of Chlorophyceae have no clearly trend during the experiment. The Cyanophyceae percentage abundance to total phytoplankton was increased from zero time to after 5 days in control and all waste A and waste B concentrations except in 80% waste A and waste B concentrations.

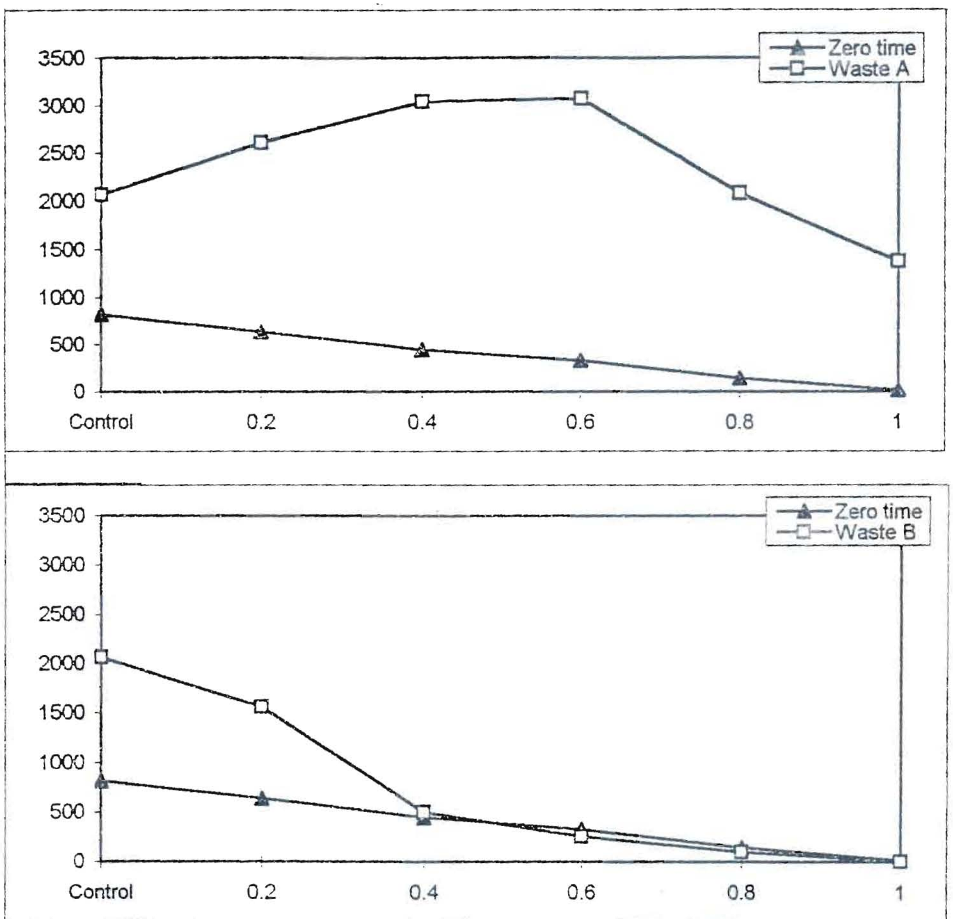

Fig. (2): Total phytoplankton (No.of cell x 10^{4} l^{-1}) at different concentrations of Control,Waste A & WasteB at Zero time and after 5 days

Cyanophyceae was the dominant class after 5 days in all waste A and waste B concentrations except in 80% and 100% A concentrations and in 60% and 80% waste B concentrations.

The most dominant species of Cyanophyceae after 5 days was *Chroococcus minutus*, which reached to its maximum number of 1396 x 10^4 units L^{-1} in 40%, waste A concentration after 5 days.

Table (4): Total phytoplankton (No. of cell x 1041^{-1}) at different concentrations of Control, Waster A & Waste B at Zero time and after 5 days.

Waste conc.	Zero time	After 5 days	
	Zero time	Waste A	Waste B
Control	818	2068	2068
20%	640	2618	1560
40%	446	3045	500
60%	332	3077	256
80%	145	2092	100
100%	11	1374	0

Table (6): Effect of different concentrations of Waste A on population densities of the leading species (No. of cell x $10^4 . l^{-1}$) at Zero time & After 5 days.

	Control		20%Waste A		40%Waste A		60%Waste A		80%Waste A		100%Waste A	
	Zero time	After 5 days	Zero time	After 5 days	Zero time	After 5 days	Zero time	After 5 days	Zero time	After 5 days	Zero time	After 5 days
Bacillariophiceae:												
Cyclotella menghiniana	30	33	36	34	29	24	12	11	7	8	0	0
Cyclotella ocellata	159	218	157	47	145	36	73	34	32	15	2	0
Cyclotella operculata	58	134	58	52	27	53	21	31	11	12	0	0
Melosira granulata	23	84	12	52	27	39	20	13	12	0	2	0
Melosira granulata var. angustissima	57	170	52	56	28	54	20	52	5	25	3	0
Nitzschia palea	1	5	1	141	5	373	7	908	4	1324	3	1369
Synedra ulna	4	44	12	52	6	27	3	15	3	5	1	0
Chlorophyceae:												
Actinastrum henzchii	8	0	10	0	10	0	8	0	0	0	0	0
Ankistrodesmus convolutus	7	25	9	52	3	77	2	99	2	66	0	0
Crucigenia rectangularis	16	20	16	38	12	40	8	20	8	8	0	0
Kirchneriella obesa	8	22	10	122	4	31	2	79	2	13	0	0
Oocystis parva	6	8	5	8	6	8	4	4	4	10	0	0
Oocystis solitaria	5	7	4	8	2	11	1	12	1	5	0	0
Pediastrum simplex	4	0	6	60	4	20	4	16	0	0	0	0
Scenedesmus quadricauda	12	24	12	22	6	60	4	46	4	34	0	0
Scenedesmus ecornis	10	40	3	40	2	93	4	52	4	4	0	0
Selenastrum gracile	4	4	4	14	1	45	1	19	1	14	0	0
Cyanophyceae (No. of units x 10 4 L^{-1}):												
Chroococcus minutus	30	118	12	1275	4	1396	3	1285	2	361	0	0
Gomphospharia aponiana	25	66	25	188	8	207	15	76	8	17	0	0
Microcystis aeruginosa	71	526	63	51	33	63	67	41	37	17	0	0
Microcystis flos-aquae	16	8	8	0	8	31	8	36	17	0	0	0

Effect of Industrial Waste on Chlorophyll *a* concentrations:

The effect of different concentrations of waste A & waste B on Chlorophyll *a* concentration during the period of experiment are given in Table (8) and Figure (3).

At zero time, the Chl.*a* content showed a gradual decrease with increasing of waste concentrations. The Chl.*a* concentration in control showed a gradual decrease with time and reached to its minimum value of 19.29 $\mu g\ L^{-1}$ after 5 days.

The Chl.*a* concentrations in all waste A concentrations showed a gradual increase with time except in 100% waste A concentration which slightly decreased till after 2 days, then sharply increased in Chl.a content after 3 days until it reached to its maximum concentration in 100% waste A after 5 days. In waste A, the maximum Chl.*a* concentration of 29.42 $\mu g\ L^{-1}$ was recorded in 60% concentration after 5 days, while the minimum value of 2.03 $\mu\ L^{-1}$ in 100% waste A concentration was observed after 2 days.

In waste B, the Chl.*a* content showed a gradual decrease with time in all waste B concentrations until it reached to its minimum values after 3 days, then slightly increased after 4 days and after 5 days in all waste B concentrations except in 60% and 80% waste B concentrations reached to its minimum values after 4 days, then slightly increased after 5 days while in 100 % waste B the concentration of Chl.*a* was zero after 1 day until the end of the experiment.

The Ec_{50} value of waste A was not recorded during the period of experiment, while in waste B, Ec_{50} was decreased from its maximum value after 1 day to its minimum value after 3 days, then slightly increased after 4 days until the end of the experiment.

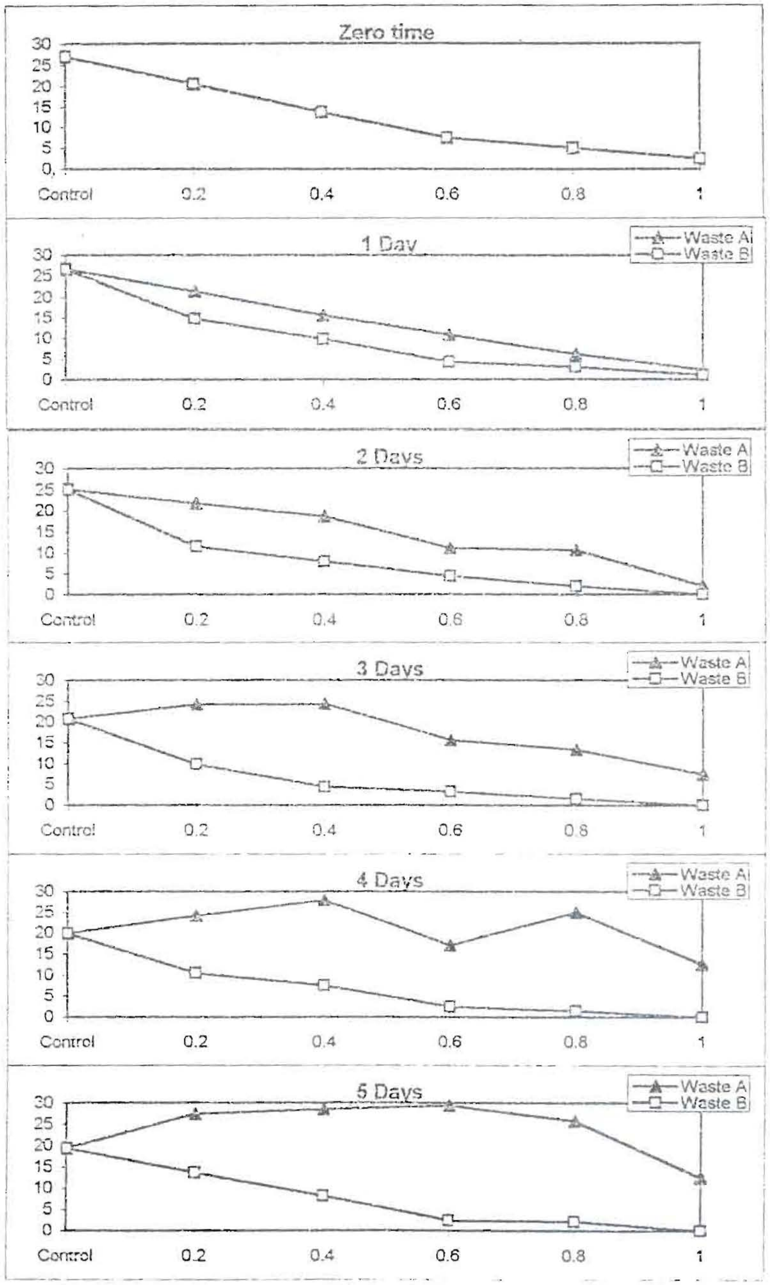

Fig. (3): Effect of different concentrations of Waste A &Waste B on Chlorophyll a ($\mu g\ l^{-1}$) during the period of experiment

et al. (2000) Reported that Cyanophyceae is the main dominant class in drainage water which was loaded with heavy metals in drainage canals in western Damietta which reached to its maximum value being 99.7,99 and 98% for Senania, Marssok and Gamassa drainage canals respectively. At the high waste A concentrations (80 % and 100 %) and waste B concentrations (60 % and 80 %) Bacillariophyceae was predominated by *Nitzschia palea*, which was the only species, found at 100% waste A. This result agrees with Nather Khan (1990 & 1991), Dickman *et al.* (1990), Joy (1990), Sudhakar *et al.* (1994), Ali (1995) and Brown & Olive (1995) who reported that *Nitzschia spp* (especially *Nitzschia palea*) were the most tolerant species to heavy metals and are used as indicator for industrial waste pollution.Also these data agree with Mona. *et al.* (2000) who reported that Nittzschia spp (*Nitzschia palea, Nitzschia sigma , Nitzschia obtusa var.scalpeliformis* and *Nitzschia filiformis*) are found as epiphytes on some aquatic plants in polluted water in the Nile Delta. There was positive correlation between Diatoms on the aquatic plants and heavy metals such as Cu and Pb and they could be used as indicator for pollution.

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