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The Physico-chemistry and Distribution of Water Hyacinth (*Eichhornia cressipes*) on the river Nun in the Niger Nelta

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ABSTRACT: The physicochemical studies and phytochemical investigations of River Nun and the water hyacinth (*Eichhornia crassipes*) were carried out in relation to the distribution of *Eichhornia crassipes* (Mart) Solms, Family Pontederiaceae in the River Nun.. The physicochemical studies of the water showed that dissolved oxygen (DO), biochemical oxygen demand (BOD), nitrate (NO_3), salinity and alkalinity (pH) had mean $\pm$ SD values of 6.94 + 0.22, 5.86 + 0.42mg/L,13.76 + 5.76 mg/L, 0.237 + 0.082 mg/L, 7.25 + 0.37 mg/L and 5.92 + 0.32 mg/L respectively. Phosphate (PO_4) and sulphite (SO_3) were not detected. The pH and DO levels appeared to favour the growth of *E. crassipes*.The BOD values were relatively higher than those of the control. The phytochemical studies showed that *E. crassipes* contains flavonoids (luteolin, apigenin, tricin, chrysoeriol, kaempferol, azaeleatin, gossypetin and orientin), amino acids (methionine, valine, glutamic acid theonine, tryptophan, tyrosine, leucine and lysine), phosphorous, protein, organic matter and cyanide. Some of these phenolic compounds and cyanide contribute to the negative impact associated with the proliferation of *E. crassipes,* in aquatic systems in addition to blocking water ways. The high protein and total organic matter content of *Eichhornia crassipes,* however, make *E. crassipes* a potential raw material for the production of animal feed and organic fertilizers. The study also shows that this plant prefers an almost neutral pH aquatic environment with a substantial concentration of dissolved oxygen, an increased rate of biochemical oxygen demand with a substantial concentration of nitrates. These conditions explain why this plant thrives in freshwater habitats such as the River Nun. @JASEM

Eichhornia crassipes is an erect free-floating and stoloniferous perennial herb, which belongs to the Family Pontederiaceae. It was first reported in Africa, in the Nile River in 1956 and has spread by 1966 to the Jebel Aulia Dam near Kherfoun (Cook, 1976). Consequently, this invasive plant was reported in Lagos, Nigeria in 1984, nearly one hundred years after it was introduced into the United States from South America at the world's Industrial and Cotton Continental Exposition of 1884-1885 in New Orleans, Louisiana, by a Florida visitor to the exposition in 1884 (Tabita and Woods, 1962). Since then, the plant has spread to other parts of Nigeria like confluence of rivers in Lokoja, and rivers and river systems in the Niger Delta such as New Calabar river in Choba, Ase river in Aghalokpe, Sombreiro river in Ahoada, Ekole creek in Yenagoa, Nun river in Amassoma, etc. (Nyananyo, *et al*., 2005)

All species of *Eichhornia*, except the African species, *E. natans* occur naturally in tropical South America where they are believed to have originated, and form conspicuous component of aquatic vegetation of shallow pools, lakes, ponds and rivers. *Eichhornia* sp. is probably the most invasive and prolific plant species in the world's rivers and canals. The plant has a doubling time of 6-18 days and a leaf turn-over rate of 60-70% per month (Mitchell, 1974; Center and Spencer, 1981; Schmite, *et al*., 1993). The environmental hazards associated with large *E. crassipes* populations is degraded water quality and drastic changes in the plant and animal community, light and oxygen diffusion are severely curtailed by this floating plant, reduction in water movement and the decomposition of the plants, if large biomass of the plants are killed at once, can use up all the oxygen in the water (Gopal,1987). Other environmental hazards associated with this plant which can live and reproduce floating freely on the surface of fresh water or anchored in mud include clogging of irrigation, hydropower and water supply ways. Hindrance of water transport, blockage of canals and rivers causing flooding (Bos, 1996). Healthwise, the fibrous root system of *E. crassipes* provide nesting habitat for a variety of disease vectors (Lymphatic filariasis, Malaria and Schistosomiasis).

Despite all the problems created by *E. crassipes*, some positive reports have been recorded. Gopal (1987) reported that *E. crassipes* contains 64% methane and can be used for biogas generation and for water purification. It is also valuable in traditional medicine, making of ropes, production of fibre boards, as animal fodders and fish feed, green manure, compost, and as an ornamental plant. The crushed roots can be used for making briquettes for fueling of stoves and for paper production (Isichei, *et al.,* 2003). However, there has been no information on the phytochemical status of this plant. Therefore,

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the aim of this project was to investigate the phytochemical staus of *E. crassipes* and determine some physiochemicalparameters that may enhance its growth in the Nun River that may be responsible for the distribution, growth, and proliferation of this plant *in situ.*

MATERIALS AND METHODS

The study area is the River Nun in Amassoma and environs in the Southern Ijaw Local Government Area of Bayelsa State. The town is situated about 40km west of Yenagoa, located approximately between latitudes 4°15'' to 4°50''N and 6°50'' to 7°50''E within the Niger Delta. The River Nun is one of the major river systems of the Niger Delta. The others are the Forcados and Orashi river systems. There are riverine communities/settlements along the river with several pier toilets. The major means of transportation is by water with engine boats and local canoes. Fishing activities go on regularly in the river with several adjoining fish ponds. Nun river is a freshwater ecosystem. The climate is typically tropical with average all year temperature in the range of 25°C-30°C (Egborge and Sagay, 1979; Tetsola, 1988; Onwudinjo, 1990). A total of 6 stations located at approximately 1km intervals were sampled. Station 6 is the control sited in a section of the river without any trace of Eichhornia sp. The samples were collected during the early rainy season, in the month of June, 2005.

Sample Collection and Analysis: Eichhornia crassipes: The plants of *Eichhonia crassipes* were collected from the sample stations along the shoreline of River Nun in Amassoma. The five stations were located along the stretch of the river covered by mats of water hyacinth. After collection, the plant materials were oven dried in the laboratory, ground with an electronic blender and stored in plastic containers at room temperature for a week before they were analyzed.

Phytochemical analysis carried out on the plant materials were based on the paper chromatographic method (Harborne, 1973). The chromatograms prepared from the plant materials were viewed under UV light for the identification of spots based on their RF values. The identification of the flavonoids were based on RF values, colour in UV plus Ammonia while that of amino acids were based on standard amino acid markers (APHA, 1976).

$$RF = \frac{DM_{sample}}{DM_{solvent}}$$

where DM_{sample} and DMsolvent are Distance moved by sample (cm) and distance moved by eluting solvent (cm) respectively.

The percentage crude protein, percentage cyanide, and Total organic matter contents of E. crassipes were determined using the ammonium distillate(boric acid solution) titration method, alkaline titration method, and combustion methods respectively, while the phosphate content was determined by sodium carbonate fusion method (Stewart *et al*., 1984 and APHA, 1976).

Water Quality: Samples for water quality studies were collected from the five stations where E. crassipes were collected using plastic containers. One other sample was collected from a section of the river not infested with water hyacinth as the control. Surface water samples were collected and analyzed at the University of Port Harcourt, Department of Plant Science and Biotechnology Anatomy and Physiology Laboratory. The concentrations of phosphate (PO_3), sulfate (SO_4) and nitrate (NO_3) were determined using spectrophotometric method (spectronic instrument model 21D) in conformity with the standard procedures as described in APHA, 1976. The pH, was determined using a Cole Parmer Digisense meter (Cole Parmer, USA). Conductivity was measured with a Lovibond instrument model type (CM-21). Dissolved Oxygen (DO) was measured with a yellow springs DO meter and probe while the Biochemical Oxygen Demand (BOD) was determined following the Winkler's method as described in APHA, 1976.

RESULTS AND DISCUSSION

The results of the phytochemical investigations of *E. crassipes* and the phytochemical characteristic studies of the water in River Nun are presented in Tables 1 – 4. Flavonoids and amino acids were detected in the samples of *E. crassipes* studied (Tables 1 and 2). Amino acids detected include glutamic acid, leucine, lysine, methionine, threonine, tryptophan and valine (Table 2).

Table 1: Flavonoid Constituent of E. crassipes using various solvents.

Flavonoid (Flavones)	BAW	RF(x100) in forestall	50% Acetic acid	Colour in UV & UV plus Ammonia
Luteolin	79.3	66.3	66.6	Dull ochre
Apigenin	87.9	83.0	-	Dull ochre
Tricin	73.4	72.84	-	Yellow
Chrysoeiol	81.8	77.0	-	Yellow
(Flavonols)				
Kaempferol	83.4	55.2	56.0	Yellow
Azaeleatin	-	-	48.7	Yellow
Gossypetin	31.2	-	-	Dull black
(Glylsy flavone)				
Orientin	31.3	-	-	Yellow

Note: BAW (Butanol : Acetic acid : Water = 4:1:5}; Forestall (Conc. HCl : Acetic acid : Water = 3: 30: 10}; 50% Acetic acid (Acetic acid : Water = 1: 1}

The high percentage total organic matter, crude protein and amino acids have all composition helped to explain why the plant is used as a valuable source of animal feed. Studies have shown that these nutrients in *E. crassipes* are a vital source of food for both ruminants and non ruminants. In South-East Asia, and Malaysia, some non ruminant animals are fed rations containing *E. crassipes* with vegetable wastes, rice, bran, copra cake and salt to make a suitable feed (Isichei*, et. al*. 2003). *Eichhornia. crassipes* is ideal for composting and can also be used as green manure. As a green manure it can either be ploughed into the ground or used as mulch. However, the decomposition of *E. crassipes* can have adverse effects on the aquatic environment, as it increases the biological oxygen demand (BOD) in the water (Table 4) due to its high organic matter content. The phytochemical analysis also revealed that the percentage Cyanide (% CN) in *E crassipes* is about 0.0216 mg/100g. (Table 3). Cyanide is a toxic substance that adversely affects living organisms. The presence of cyanide in *E. crassipes* further explains the reason why most aquatic organisms (both plants and animals) are displaced or inhibited from areas that are infested by the plant. Indeed, it is the ability of cyanide ions to bond with iron ions that is partly responsible for their action as poisons. Cyanide interferes with the Cytochrome oxidize peroxidase and thus disrupts respiration with often fatal effects. The complexes of cyanide with zinc and cadmium are the most fatal. Concentrations of cyanide below 0.1ppm are rapidly fatal to fish. The cyanide on *E. crassipes* can be released into the water through decomposition.

The pH of the waters of River Nun (6.94 ± 0.22) (Table 4) favours the growth requirements of *E. crassipes* and other aquatic organisms.

Table 2: Amino Acid Constituent of E. crassipes using BAW

Solvent used	Amino acid identified	Colour with 1% minhydrin tuv.
BAW	Methionine	Violet
	Valine	Violet
	Glutamic Acid	Violet
	Threonine	Violet
	Tryptophan	Grey
	Tyrosine	Grey
	Leucine	Violet
	Lysine	Violet

Solvent key : BAW = n Butanol – Acetic Acid-water = 4: 1: 5

Table 3: Result of Analysis for various parameters in *E. crassipes* (mg/100g).

% TOC	%CN	%TOM	% Crude Protein	% PO_4
1.26	0.0216	90.8	10.93	0.304

It was also observed that there was just a little difference between the pH of the water that is underneath the mats of *E. crassipes* and that of the water that is free from *E. crassipes* mats. The concentration of the dissolved oxygen (DO) in the water is above the minimum limit of 5.0mg/l in fresh water that is necessary for the survival of aquatic fauna (William, 1999). The values of BOD, however, showed great variation among the stations (Table 4) Whereas station 3 had the highest BOD concentrations of 12.8mg/l, station 2 had the lowest

of and 8.0mg/l. This may be as a result of the fact that many of the plants were dead underneath the densely populated *E. crassipes* mats; since the percentage total organic matter (%TOM) in the plants are high (about 90.8mg/100g) and thus, requires higher amounts of dissolved oxygen to decompose. Station 4 also has a relatively high amount of BOD. This is because it shares similar environmental factors with station 3. The BOD in stations 2 and 5 were however the lowest (8.0mg/l and 9.6mg/l respectively). This may be due to the high flow rate of water in these stations and also lesser dead plants in the stations. When the BOD in all the sample stations were correlated with that of the control, it was observed that the BOD in most of the sample stations were relatively higher than that of the control (Table 4).
of Benin City. Nigeria.

Table 4:

Sample stations	pH	DO	BOD	Conductivity	PO_4	NO_3	SO_3	Salinity	Alkalinity
Station 1	7.16	5.76	12.8	0.29	NIL	0.252	NIL	7.25	6.0
Station 2	6.97	6.56	8.0	0.33	NIL	0.218	NIL	6.88	6.0
Station 3	6.87	5.92	22.4	0.28	NIL	0.185	NIL	7.25	5.8
Station 4	6.90	5.60	16	0.31	NIL	0.319	NIL	7.25	5.6
Station 5	6.78	5.44	9.6	0.29	NIL	0.210	NIL	7.61	6.2
Mean(X)	6.94	5.86	13.76	0.30	NIL	0.237	NIL	7.25	6.92
Confidence	6.94±	5.86±	13.76±	0.30±	NIL	0.237±	NIL	7.25±	5.92±
Limit	0.22	0.42	5.76	0.02	NIL	0.082	NIL	0.37	0.32
Control									
	pH	DO	BOD_5	Conductivity	PO_4	NO_3	SO_3	Salinity	Alkalinity
	7.62	5.92	9.6	0.24	NIL	0.344	NIL	6.88	5.2

Physicochemical parameters of water samples from River Nun, in Amassoma. Bayelsa State, Niger Delta, Nigeria

Note: The concentration of DO, BOD, PO_4, NO_3, SO_3, Salinity and Alkalinity are in mg/L (milligrams per litre).

The high concentration of dissolved oxygen and the absence of sulphates and phosphates may be attributed to the assertion that the water in the River Nun has a high rate of self-purification. Furthermore, it can be said that the high densities of *E. crassipes* in this river may be responsible for the depletion of these plants nutrients (phosphates, nitrate and sulphates) from the water. The plant is however, sustained by the presence of nitrates in the water, which are essential plant macronutrients.

The salinity of water 7.25mg/l was low enough to favour the proliferation of *E. crassipes*. The salinity as well as the alkalinity showed very minimal variation among the stations (Table 4).

Conclusion: Eichhornia crassipes was found to be rich in flavonoids, amino acids, crude protein, cyanide, phosphate, organic matter and organic carbon. It grows in an almost neutral pH, substantial concentration of dissolved oxygen, an increased rate of biochemical oxygen demand, a substantial concentration of nitrates, and very low salinity and alkalinity. The results of this study are in conformity with the phytochemical analytical results of this plant by Nyananyo *et al*., 2005. This shows that the plant is likely to be found in freshwater environments. However, the absence of sulphates and phosphates indicates that the nutrient concentration of the water is very low. This could be as a result of the combined effect of absorption of the available nutrients by *E. crassipes* and the high rate of self purification by the water body.

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