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PIGMENTAL COMPOSITION AND PHYSICOCHEMICAL PARAMETERS ON THE WATER QUALITY OF SALOG RIVER IN HILONGOS, LEYTE, PHILIPPINES

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ABSTRACT

The study was conducted to determine the pigmental composition of freshwater algae in Salog River, investigate the physicochemical properties of its water, and evaluate the quality of the river based on standard limits set by the national and international environmental agencies. Results of the pigmental analysis showed that chlorophyll a ranged from 1.226 to 28.238 ppm, chlorophyll b ranged from 3.526 to 21.180 ppm and total carotenoids from 2.274 to 7.994 ppm. The pigment composition of the freshwater algae showed a strong, positive correlation with the phosphorus, pH, TDS and conductivity levels of Salog River. On the contrary, only with TSS that the pigment composition of the algae showed a strong, negative correlation. On the other hand, the phosphorus (0.045-0.187 ppm), total dissolved solids (202.4-306.2 ppm) and total suspended solids (21.7-49.8 ppm) are below the tolerable limits set by DENR, WHO and USEPA. However, the pH (6.3-8.9) and conductivity (305.8-443.0 µS) values were within the standard limits. Thus, Salog River has a good water quality.

I. INTRODUCTION

Freshwater is a finite resource and is very essential for agriculture, industry and even for human existence. Without adequate quantity and quality of freshwater, sustainable development would not be possible (Bartram & Balance, 1996). Water quality is a measure of the environmental conditions of a water resource (Chapman, 1992). During the past decades, countries have increased their interest in water quality monitoring programs due to the worldwide concern that good quality freshwater may become a scarce resource in the near future (Pesce & Wunderlin, 2000; Bordalo *et al.*, 2001; Jonnalagadda & Mhere, 2001). Until now, water quality monitoring programs are still very important since they involve taking measurements that give the information needed for the assessment of the water conditions in relation to natural variability, human effects and intended uses (Chapman, 1992). Specific variables, which provide general indications of water health, are of primary concern since it is difficult to measure all the properties of a water body (Robertson & Davis, 1993). An important component of biological monitoring programs for evaluating water quality is algal growth (Bruun, 2012). Algae are a highly diverse group of organisms that have important functions in ecosystem (Ramaraj *et al*., 2010) and are considered as the primary producers within the aquatic ecosystem because they create their own chemical energy through photosynthesis (Sanders, 2000). They are valuable in this field of study not just because they respond quickly to changes in water chemistry (Bruun, 2012) but also because they are used in the primary production quantification, nutrient status and harmful algal bloom monitoring and for drinking water managements (Sanders, 2000). Their growth can be measured by analyzing their pigment composition (Cevik *et al*., 2005). The pigment concentrations and other water quality parameters such as pH, temperature, total suspended solids and total dissolved solids have been correlated to assess water quality (Jones & Lee, 1982). This study aimed to determine pigmental composition of freshwater algae in Salog River, investigate the physico-chemical properties of its water, and evaluate the water quality of the river system in Hilongos, Leyte.

II. MATERIALS AND METHODS

Samples of freshwater algae and water for the physico-chemical studies were collected in the upstream, midstream and downstream regions of the Salog River system. For the physico-chemical sampling, one point five-liter acid-washed polyethylene bottles were used as sample containers for the water samples. Small centrifuge tubes, which are made of plastic covered with carbon paper, were used as containers for the freshwater algae samples. Pigments in freshwater algae were extracted using 80% acetone for two hours. *Chlorophyll a*, *b* and total carotenoids were analyzed using the UV-Vis spectrophotometer. The method of Dere *et al.* (1998) was followed for pigmental analysis.

Five physicochemical parameters such as pH, electrical conductivity, total dissolved solids, total suspended solids, and phosphorus were evaluated to correlate with the pigmental composition of freshwater algae in the river. Regression analysis between the physico-chemical parameters of water and the pigment composition of the freshwater algae was made. Assessment of the water quality in Salog River was made by referring the values obtained on physico-chemical parameters with the standard limits set by DENR, WHO and US EPA. A one-way Analysis of Variance (ANOVA) and Least Significant Difference (LSD) test were used to compare significant differences among the pigment composition and the physico-chemical parameters.

III. RESULTS AND DISCUSSION

Pigmental analysis of freshwater algae and physico-chemical parameters of Salog River in Hilongos, Leyte

The pigment composition of the freshwater algae of Salog River can be affected by the physico-chemical parameters of water such as pH, total dissolved solids, total suspended solids, conductivity and phosphorus concentration. Tables 1 shows the results of the pigmental analysis of freshwater algae and the physico-chemical properties of Salog River in the three-month study. The pigment composition of the freshwater algae were highest in the second month of the study, where the phosphorus concentrations were lower. In contrast, at high P concentrations, the pigment composition of the freshwater algae were lowest during the third month of the study. High nutrient concentrations resulted in low algal growth (Yonkey, 2004), thus low pigment composition was observed as well.

Table 1. Pigment composition of freshwater algae and physico-chemical parameters in Salog River

Sampling Months	*Chl a* (ppm)	*Chl b* (ppm)	Total chl (ppm)	Total car (ppm)	pH	TDS (ppm)	TSS (ppm)	Conductivity (μS)	P (ppm)
April	18.059	8.511	26.570	4.775	7.7	240.3	34.1	355.5	0.050
June	19.892	11.592	31.484	5.355	8.2	250.5	27.0	369.1	0.176
August	16.642	13.133	29.776	4.178	8.6	208.1	24.7	313.7	0.186

The pH values were found highest during the second and third months of the study which in turn gave the highest pigment composition of the freshwater algae. However, pH values did not vary significantly, which suggested that algal growth was not affected greatly by large fluctuations in pH. High conductivity values were obtained during the second month of the study while low conductivity values were gathered during the third month. These results still correlated with the pigment content of the freshwater algae, wherein a direct relationship was observed between the two variables. Pigment composition increased with increased conductivity and oppositely decreased with decreased conductivity. The total dissolved solids were found highest in the second sampling month, where the pigment contents of the freshwater algae were also at their highest. TDS is a measure of inorganic salts, organic matters and other dissolved materials in water. Algal growth is favored with the presence of nitrogen- and phosphorus- containing salts resulting to the development of pigments.

Algal growth could also be affected by the particulate matter suspended in the water column, termed as the total suspended solids (TSS). Results showed that highest TSS value was gathered during the first month of the study where there was low pigment composition. Decreased pigment composition was due to the attenuation of light caused by increased TSS. Light attenuation would limit the growth of algae, since the primary requirement for algae to conduct photosynthesis and develop was sunlight. Yet, in the study, there was no significant difference observed in TSS values, thus, it did not significantly affect the pigment development.

Correlation analysis was done between the physico-chemical parameters and the pigment composition to provide a means of defining a mathematical relationship between the two variables (US EPA, 2000). The pigment composition of the freshwater algae was correlated with the phosphorus concentration in Salog River. The highest degree of linearity was generated between *chlorophyll a* and TDS ([*Chl a*] = 0.0755 [TDS] + 0.046; R^2 = 0.987), *chlorophyll a* and EC ([*Chl a*] = 0.0549 [EC] – 1.3036; R^2 = 0.9899), *chlorophyll b* and phosphorus concentration ([*Chl b* = 30.075 [P] + 6.9485; R^2 = 0.9313), total carotenoids and TDS ([Total car] = 0.0269 [TDS] – 1.704; R^2 = 0.9615), and total carotenoids and EC ([Total car] = 0.0196 [EC] – 2.1933; R^2 = 0.9666) which suggested that the aforementioned pigments were significantly affected by the said parameters.

Water quality assessment of Salog River in Hilongos, Leyte based on pigmental composition and physico-chemical properties

Physico-chemical parameters of Salog River were referred with the standard limits set by different environmental agencies such as the DENR, USEPA and WHO to evaluate the water condition of the river system. Table 2 shows that most of the parameters measured, except for pH and conductivity, were below the tolerable limits set by the above mentioned environmental agencies. Consequently, for pH and conductivity, results were within the tolerable limit. With these alone, the water quality of Salog River system could be considered healthy and safe to humans and to the aquatic organisms.

Table 2. Water quality assessment of Salog River in Hilongos, Leyte

Parameters	Water Quality Values			
	Salog River	DENR	WHO	US EPA
pH	8.6	6.0-9.0	6.5-9.2	6.5-9.0
P (ppm)	0.137	0.2	-	-
TDS (ppm)	208.1	1000	600-1000	500
TSS (ppm)	24.7	50	-	50
EC (µS)	313.7	-	-	50-1500

Yet, the physico-chemical parameters are not the only parameters to be considered in assessing the health condition of a river system. Algal growth is also an important component in biological monitoring programs for evaluating water quality (Brunn, 2012). Since algal growth is greatly affected by several factors such as nutrient levels, particularly phosphorus in this study, pH changes, conductivity, TDS, TSS and other physico-chemical parameters, these variables were correlated and were discussed in the previous section. In addition, since the tested physico-chemical parameters were below and within the tolerable limits set by the different environmental agencies, thus, the algae found in Salog River were suitably growing in normal conditions.

Freshwater algae are beneficial because they serve as indicators of ecosystem conditions and they can provide valuable insights in terms the biological status of an aquatic system. Nevertheless, the presence of algae did not make the river polluted. Through the pigmental analysis of the freshwater algae and the physico-chemical parameters, the water quality of Salog River was evaluated to be environmentally healthy and safe to humans and to the aquatic organisms.

IV. CONCLUSIONS

Based on the gathered data, the following conclusions are drawn:

1. The freshwater algae in Salog River have *chlorophyll a* of 1.226 – 28.238 ppm, *chlorophyll b* of 3.526 – 21.180 ppm and total carotenoids of 2.274 – 7.994 ppm;
2. Salog River has pH of 6.3 – 8.9, TDS of 202.4 – 306.2 ppm, TSS of 21.7 – 49.8 ppm, conductivity of 305.8 – 443.0 µS and phosphorus concentration of 0.045 – 0.187 ppm; and
3. The phosphorus, TDS and TSS levels in Salog River are below the water quality standard limits set by DENR, USEPA and WHO, however the pH and conductivity values are within the tolerable limits. Thus, Salog River is not polluted and is safe to humans and aquatic organisms.

V. RECOMMENDATIONS

For further studies, the following recommendations are hereby suggested:

1. Include other algal species for future endeavor of similar nature;
2. Monitor the physico-chemical parameters of water in the culture;
3. Study on other pigments for algal studies; and
4. Establish the order of correlation between pigment composition and physico-chemical parameters.

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