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Biochemical Indices in Ecology: A Catalyst in Environmental Study

Nwaichi EO[1,2]* and Essien EB[2]

[1]The University of Nottingham, Nottingham, UK
[2]University of Port Harcourt, Port Harcourt Nigeria, Nigeria

Abstract

Environmental challenges has continued to threaten the existing unsustainable global living. The debilitating impact on environment arises from employed techniques or effects of such techniques and requires sensitive and effective monitoring indicators for its evaluation. Borne out of increasing complexity of environmental problems and apparent strained resources of government, researchers, industries and decaying food production and water supply, a review of indices of interactions between organisms and the environmental factors that impact them in a bid to foster environmental protection and nature conservation which are core elements of ecology, is therefore pertinent.

Keywords: Biochemistry; Environmental quality; Microbial community; biological indicators of pollution; Biomarkers.

Commentary

Biochemistry, the study of chemical processes within and relating to living organisms [1] or chemistry of living matter, deals with the structures, functions and interactions of biological macromolecules. Biochemical indices traverses genetics and molecular biology with emerging novel roles for RNA [2]. Ecology is the branch of biology that deals with relationship among organisms and to their physical surroundings. It is a branch of science concerned with the interrelationship of organisms and their environments [3] or simply the totality or pattern of relations between organisms and their environment. Ecological diversity measurements [4] are necessary to understand survival and adaptability of species. The role of biochemistry in interactions between organisms or between an organism and its environment (soil, water and air) cannot be overestimated.

Soil biological processes, such as organic matter degradation, mineralization, and nutrient recycling, are basically driven by microorganisms and enzymes. Frac, et al. [5] reported that community level physiological profiling using Biolog EcoPlates can be used as sensitive and effective indicator for evaluation of microbial functional diversity and community of soil under sewage sludge-treatment. Also, the possibilty of early detection of soil physical and chemical properties from modification in biological properties, including microbial community has been documented by Szarlip, et al. [6]. The ratio of total Nitrogen calculated from biochemical soil properties (Nc) (biomass C, mineralised N, phosphomonoesterase, β – glucosidase and urease activities) to that measured by Kjeldahl method (Nk) was used as an index of soil quality in disturbed soils; in all cases, soil degradation was reflected in Nc/Nk values [7]. The researchers recommended the adoption of the Nc: Nk for evaluation of soil degradation as it distinguishes among biochemically balanced, activity transient and degraded soils and its application in the rapid calculation of ecological dose, ED_{50} of soil pollutants. Soil productivity has been linked to biochemical activity. The quality of soil is related to the maintenance of equilibrum between organic matter content and these five biochemical indices. Nwaichi and Frac [8] recorded correlation of the 5'-terminal restriction fragments generated after Csp digestion of 16S rRNA gene with observed DNA concentrations in the soil community profile and revealed loss of diversity with crude oil pollution. They posited that the herculean nature of the study of complex diversity pattern of the microbial community in parched and inundated soil environment may have arisen from inadequate biological classification of such environment. Molecular methods have the advantage of obtaining information about uncultivable organisms and can be applied to study complex trophic interactions in the field and to address underlying ecological questions. A wholistic understanding of soil microbial communities has been broadly defined by biochemical-based techniques and molecular-based techniques [9]. Similarly, using Average well colour development in BIOLOG system with 95 different carbon sources used to produce a metabolic profile of microorganisms, Nwaichi and Frac [8] showed wide distribution in soil community spread.

According to Chícharo and Chícharo [10], the ratio of RNA to DNA (known as standardized RNA/DNA ratio) has been widely used as a biochemical index to assess potential survival and growth and in determining the ecophysiological condition of marine organisms. Besides becoming a particularly promising biochemical tool that not only reflects physiological condition, this index also allows for the estimation of instantaneous growth rates in a great variety of organisms [11-13]. Chícharo and Chícharo [10] also reported validation of standardized RNA/DNA ratio for study of marine small animals. Cytochrome P450, a biomarker often used in the studies assessing aquatic environment pollution has proved to be a very suitable method for biochemical and environmental monitoring of aquatic environment quality [14]. In Czech Republic, Marcela, et al. [15] employed liver enzymes of phase I and phase II of xenobiotic transformation, namely cytochrome P450, ethoxyresorufin-O-deethylase, glutathione-S-transferase and tripeptide glutathione to assess the contamination status of different rivers. They reported that these biomarkers are very suitable and useful tool for monitoring of aquatic pollution in the study Czech rivers. The relationship between levels of biochemical markers in fish liver and the ambient level of organic pollutants in fish muscle and bottom sediment were demonstrated in the said study.

The use of Ascorbic acid content [16], chlorophyll content [17],

***Corresponding author:** Nwaichi EO, The University of Nottingham, Nottingham, UK, Tel: 234(0)8056031989; E-mail: nodullm@yahoo.com

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leaf extract pH [18] and relative water content [19] have been used to determine the sensitivity and tolerance of plants to air pollution. In their study, Tanee, et al. [20] concluded that air pollution tolerance indices of monitored plants were of the sensitive category and hence can be used to monitor air quality of Niger Delta. Based on their results, air pollution tolerance index, APTI obtained using the four leaf biochemical status can serve in predicting air quality condition of an area and these biochemical parameters are important in the study of plant-environment interactions as they can serve as bioindicators of air pollution. In the same vein, Krishnaveni and Magesh [21] investigated air pollution tolerance index using some biochemical indices and submitted that most of study the plants were sensitive to parameters and advanced the added merits of these indices to include simplicity, cost-effectiveness of process and equipment. The plant species which are more sensitive act as biological indicators of air pollution. Increased number of important biochemical parameters gave more accurate and reliable results in air quality and exposure study caried out by Sarika, et al. [22]. Furthermore, their results from calculation of APTI values of twelve different tree species revealed that all monitored biochemical parameters are important and greatly govern in evaluation of APTI values and thus, selection of suitable tree species to remove/reduce air pollution.

Biochemical systematics and ecology has accelerated understanding of environmental assessment, monitoring and management and should be further explored in related field. Environmental biota, processes, function, and the interactions has been to a great extent, revolutionized by biochemical indices. In a time of great global environmental crises, increasing complexity of environmental problems and obvious strained resources of the regulators and polluters, most reliable approach to studying ecology has become an increasingly important topic.

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