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Impact of Biomarkers in Environmental Toxicity

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Abstract -

Biomarkers are increasingly being used in environmental monitoring to provide evidence that organisms have been exposed to, or affected by, xenobiotic chemicals. Usually, these biomarkers rely on biochemical, histological, morphological, and physiological changes in whole organisms. With many other research-based disciplines, environmental toxicology has profoundly benefited. As a result of these accomplishments, experimental studies of biomarkers have developed into a multidisciplinar research area. Biomarker scan range from the very simple ones, such as a blood hemoglobin measurement, to very complex and expensive determinations, e.g., of DNA adducts. In applying biomarkers in environmental health and preventive medicine, ethical issues must be addressed. New biomarkers are urgently needed desanintegral too linpreventive medicine and environmental health. In the present paper, we briefly discuss the application of biomarkers in ecotoxicology and ecological risk assessment, and we provide examples of how they have been applied.

Keywords : biomarkers, environmental toxicology, environmental health.

Introduction :-

Various pollutants present in the ecosystem due to human activities enter the environment and cause severe damage to the ecosystem and the organisms present in it. Due to the diversified pollutants chemical nature and the various level of toxicity the risk assessment is a difficult task. The continuous exposure even in minute quantity have an adverse effect on the environment. Thousands of pollutants enter daily into environment and exert various kinds of stress on organisms and ecosystems. Risk assessment of these pollutants to organisms and ecosystems is challenging because of diversities in chemical nature and mode of toxicity of the pollutants as well as variation in sensitivities of the organisms exposed to the pollutants. Even in the low concentrations these pollutants produce harmful effects on organisms, which are difficult to be predicted as only after prolonged exposure only measurable effects are expressed. The toxicity of these pollutants can be detected by the biomarkers which responses towards xenobiotics toxin present in the environment. The past few decade has seen varied research investigation of biomarkers and practical application for risk assessment and environmental health management. Therefore, it is necessary to develop early warning signals or biomarkers that persuasively reflect adverse biological responses towards

environmental toxins even at minute concentrations. A biomarker is defined as "a change in biological response, ranging from molecular through cellular and physiological responses to behavioral changes, which can be related to exposure to or toxic effects of environmental chemicals". Recent developments in molecular biology and biotechnology and inventions of sophisticated instruments have led to the development of novel, more sensitive validated biomarkers of exposure, effect, and susceptibility to the adverse effects of terrestrial and aquatic pollutants. Systematic use of multiple biomarkers has been found as most useful in the assessment of pollutants' effects.

Environmental toxicology deals with complex interactions between thousands of environmental chemicals and its adverse effects. When a single xenobiotic has different targets, a biomarker may exist that reflects the integrated response of the organism. A particular marker is likely to represent only one individual toxic pathway. The increase in pollution by heavy metals has focused attention on the behavior of these metals in aquatic ecosystem, Biomarkers have considered as valuable tools in biomonitoring of pollution caused by these heavy metals. Biological markers reflect molecular and cellular alterations that occur along the temporal and mechanistic pathways connecting exposure to toxic chemicals or physical agents and the presence or risk of clinical disease. Biomarkers include a vast array of measurements that reflect exposure, effect, and susceptibility.

Biomarkers are used as early warning systems signalling potentially compromised situations. The biological response should occur in the interval between the ideal conditions and the onset of lethal conditions of the organism under observation. Many researchers concentrated on studies to develop biomarkers of exposure to chemicals and applied these for human monitoring. Main goals are to develop biomarkers that reflect specific exposures and permit the prediction of the risk of disease in individuals and groups. In this case biomarkers become an important tool in clinical practice, scientific research, and public health and even in the determination of policies. An ideal biomarker should have the following properties - Could be measured on a readily available and harmless biological sample. - Should measure the extent of exposure or the harm given to the living organism. - Should be related directly with action mechanism of the pollutants - Should be an extremely sensitive technique which requires very small samples. - Should be easy to conduct and cheap (Cost effective). - Should be convenient for different species. In the field of toxicology, there are very interesting prospects for biomarkers, which are specific biochemical, genetic, morphological or physiological changes measurable in each organism and which are associated with particular stress situations (for instance, in the presence of heavy metals, pesticides, etc.). One of the shortcomings of the ecotoxicological approach is perhaps that it fails to take into account also the impacts of environmental xenobiotics on

population dynamics, community structure and ecosystem processes. Therefore, the measurement of single functions can be of very little significance if it is not related to measurements of Darwinian fitness such as growth rate, reproductive output and offspring viability.

Substantial efforts have been devoted to developing and applying biomarkers for use in ecotoxicology. These efforts have resulted partly from a desire for early warning indicators that respond before measurable effects on individuals and populations occur and partly as an aid to identifying the causes of observed population- and community-level effects. Whereas older biomarkers focused on measures of organism physiology or biochemistry, advances in molecular biology are extending the biomarker philosophy to the level of the genes (i.e., ecotoxicogenomics). However, the extent to which biomarkers are able to provide unambiguous and ecologically relevant indicators of exposure to or effects of toxicants remains highly controversial. Suites of biomarkers are only likely to provide increased predictability if they can be used in a comprehensive mechanistic model that integrates them into a measure of fitness. Until this can be

achieved, biomarkers may be useful for hypothesis generation in carefully controlled experiments. However, because the aims of environmental monitoring and ecological risk assessment are to detect and/or predict adverse chemical impacts on populations, communities, and ecosystems, we should be focusing our efforts on improving methods to do this directly. This will involve developing and testing models of appropriate complexity that can describe real-world systems at multiple scales.

Biomarkers Epitomized for Aquatic Pollution :-

Selected bio markers in different organisms can represent sensitive indexes, or early warning signals of effectors, viz, measuring stress by contaminants on the organism, and are effective sentinels for biomonitoring, both in the marine and freshwater environment. Among the aquatic organisms susceptible of research, fish have become an interesting subject because the effect factors on fish health temperature changes, habitat and water quality deterioration as well as aquatic pollution which may result in mortalities and population decline. That is why the innate immune responses in fish is considered as suitable biomarkers for monitoring biological effects of pollution induced by xenobiotics on fish immune responses.

Metals are binding molecules with biologically active constituents of the organisms body such as lipids, amino acids and proteins, that under stress conditions induced by excess of certain heavy metals, like nickel, exhibit a significant decrease in total glycogen content of gill, digestive gland and whole body freshwater bivalve, Parreysia cylindrical. On the other hand, increases in the level of pollutants increases also the levels of cortisol, which have a marked modulatory potential on immune functions and hence promissory to be used as a biomarker. Several agencies have

addressed the importance of tracing sources and fates as well as the effects of contaminants into aquatic ecosystems, such as estuaries where effects have been most strongly observed. Effective role of biomarkers was developed from analysis of DNA of fish from polluted sites revealed the biomarker presence of DNA adducts containing aromatic or bulky hydrophobic moieties not present in DNA of fish from an unpolluted reference site.

Conclusion:-

The development of biomarkers in the environmental field for the preventive identification and the prevention of harmful effects is highly needed. It is therefore extremely vital to use biomarkers towards the prevention of events that are destructive both to humans and ecosystems. Biomarkers could be used as potential tools for environmental quality assessment. Scientific research on biomarkers tries to identify those biomarkers that have a high ecological level, that is biomarkers that are linked with specific changes in the Darwinian fitness. Biomarkers are also very useful in the bioremediation or environmental restoration. With respect to, this it is very important to adopt a non-destructive approach that does not involve the sacrifice of animals. These techniques allow to monitor the modification of some biochemical parameters in the different phases of environmental restoration without damaging the organism. We conclude that biomarkers can be helpful for gaining insight regarding the mechanisms causing observed effects of chemicals on whole-organism performance and may, in some cases, provide useful indicators of exposure. In conclusion, current researches tend to identify, develop and verify biomarkers that are highly sensitive, inexpensive and easy to use.

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