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Mini review

The Complex Framework of Biosensors in Changing Environments and the Role of Green Chemistry

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Abstract

The use of biosensors in complex media with changing properties is a challenge because most of the biosensors are adapted to specific conditions. It is important to improve our research to get easy and adaptable biosensor analytical systems to characterize and control pollution in water and soils that could be applied to ensure sustainable development and guarantee the achievement of SDGs. Promising research based on Green Chemistry has been done using natural compounds to prepare biosensors.

Keyword: Piezoelectric; photo electric; gas; soil; wastewater

Introduction

The use of renewable sources is the key to maintain the future human activity, under to concepts: circular economy and zero waste. However, resources are affected by human activities diminishing their amount and quality, and relevant examples are soils and water. Water scarcity and poor quality are two of the major issues that challenge humans. We need sources of water in good conditions and enough quantity to satisfy a growing population in the Earth which will be expected to be 9.8 billion in 2050 [1]. In the same way, soils are becoming a limiting factor for cultivation and to supply enough food for people [2]. Water needs to be depurated before its use by humans because the presence of organisms and pollutants can affect severely our health. It is desirable to control water systems and prevent health affections. Moreover, the presence of pollutants in soils is a serious risk and the identification of polluted soils is even more necessary to facilitate healthy food production. The use of biological compounds for analytical systems is a good strategy to measure characteristics in the environment. Immune assays have been increasing their role in the laboratory framework, because under controlled environment and adequate processing of the samples, we can achieve good results. However, when we have to measure in changing environments, in field conditions, these types of determinations are very complex.

Analytical Challenges

New emerging pollutants like pesticides, pharmaceuticals and nano pollutants are presented in water (wastewater, irrigation water…) and soils, and they are spreading all over the world (diffuse pollution) making necessary to detect them. However, the limits of detection are becoming critical in two ways: the need to determine small amounts presented in soils and water and the necessity of analytical procedures that would be easily adopted by administrations in many countries (including developing countries) to ensure water quality and healthy soils. The role of biosensors to solve this problem would be very important. In biosensors a biologically induced recognition event is converted into a usable (bio)chemical signal [3]. These analytical devices can

be used for the detection of pollutants substances in water and so much work has to be done considering the soils. Scientists have the opportunity to develop this type of systems that combines a biological component with a physicochemical detector.

Accuracy and precision are also characteristics needed in biosensors as our measure has to be close to the true value and the repetitions of the same measurement have to be consistent. The key to a good biosensor is the sensitivity of the biological component to respond to external stimuli. However, the transformation of the signal produced by the stimulation of the biological component in a physicochemical way is still a problem associated to accuracy and precision. The biosensors can be classified as: a) effect-specific biosensors which are stimulated by modifications to physiological and chemical conditions, such as pH, temperature, or osmotic changes, or pollutants that give rise to a specific type of toxicity or b) compound-specific biosensors respond to only one type of pollutant or compounds with similar chemical features [4].

Green Chemistry and Biosensors

One of the most promising areas to improve the measurements with biosensors is the bio electrocatalysis, a very important research fields in electrochemistry and provides a firm base for the application of important technology in various bio electrochemical devices [5]. Another one is the use of green materials like the lignin as the latest research advances in industrial lignin conductive hydrogels, including biosensors, strain sensors, flexible energy storage devices, and other emerging applications are demonstrating [6]. Nanotechnology is facilitating the use of biological derived compounds that can be used in many environmental applications. This is the case of the biopolymers like nanocellulose, which is one of these eco-friendly functional materials [7]. Following the principles of green chemistry, organic carbon dots, produced from organic precursors, including naturally occurring substances, show promising characteristics especially suitable for photoelectric applications [8]. These carbon dots have shown interesting properties (optic, piezoelectric, photoluminescent…) that can be used to prepare biosensors.

Fluorescence is one of the properties of this material that can facilitate the transduction of the signal from a biological reaction into a physical way for measuring and green chemistry is giving some good results in the use of carbon dots providing potential applications in biosensing [9]. The development of organic devices is critical when they are going to be used in a complex media like the soil due to the heterogeneity of the components and the different and changing states (solid, liquid, gas). This matrix makes very complex to have a biological element (like microorganisms, cell receptors, enzymes, antibodies, nucleic acids, among others) without quick alteration and diminishing the viability of the biosensors. However, green chemistry and nanotechnology can help us to prepare and use new devices adapted to complex matrix like soils and waste waters.

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