INTRODUCTION OF NANO-BIOSENSORS IN AGRICULTURESECTOR

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Abstract

In a varied variety of research fields and our everyday lives, nanotechnology has arisen as a gift to mankind. In comparison to traditional biosensors, the use of nanotechnology in the development of biosensors results in a highly effective nano-biosensor with a small structure. In order to track agrochemicals release in pest and pathogen protection, it detect the existence of plant viruses, assess the soil nutrient content and release Nano-encapsulated slow release fertilizers without wasting them with Nano-sensing and Nano-based smart distribution systems. As a result, there is a lot of hope that such machines can help sustain agriculture by increasing production and productivity. In a vast array of fields of research and in our everyday lives, nanotechnology has emerged as a gift to mankind. As nanotechnology is used to advance biosensors, it results in a more robust nano-biosensor with a smaller structure than traditional biosensors. Nano-biosensors may detect a broad range of herbicides, fertilizers, insecticides, pesticides, moisture, bacteria and soil pH, among other things. When used properly and in a managed manner, nano-biosensors can help to promote sustainable agriculture and increase crop productivity..

Key words: Agriculture, Biosensors, Herbicides, Nano-biosensors, Nanotechnology.

Introduction

Agriculture's access to total land and water supplies is increasingly dwindling, resulting in massive losses in agricultural production. In addition, the increasing levels of farmlands are affected by herbicides, pesticides and heavy metals. Only with the aid of digital technologies and a growing inflow of new technology into this market will solve these issues effectively. Nanotechnology is now considered to be a rapidly developing sector with significant potential for agricultural and food system transformation. It is considered a possible instrument for enhancing agricultural and natural resource production. It has the potential to improve the rural economy by encouraging sustainable production, lowering farm prices, and increasing commodity value. In light of the current situation and the benefits of nanotechnology, this research discusses the role of Nano-biosensors in promoting agriculture in feeder for the increasing world population. In terms of elements, pH, microbial load, humidity and other variables Nano-biosensors can be incredibly useful to calculate the soil content and thus be used to increase productivity [1].

A Nano-biosensor is a revised version of an analytical small device or processor that has a physical-chemical transducer and a biologically derived sensitized agent [2]. In 1967, the primary biosensor was discovered, and several different biosensors were invented. Biosensors have been around since the early twentieth century, but their applications were limited to labs[3]. As technology progressed, many new biosensors were developed. There are three so-called "generations of bio-medicinal sensors; electricity biosensors operated in the first generation; the later biosensor works with unique "mediators" between the transducer and the reaction for an optimized response and the reaction does not specifically impact substance or mediator distribution itself in third generation biosensors [4].

1.1 Nano-biosensors:

In the 21st century nanobiosensors were designed based on nanotechnology principles, along with fabulously devoted miniature sensors having high miniaturization. Researchers have recently developed biosensors with unparalleled spatial and temporal precision and durability by integrating nano-sciences, electronics, computers, and biology[5]. Nano-biosensors are nanosensors that have been selective of the target analyte molecules with immobilised bioreceptor samples. Usually, a nanobiosensor is designed to capture, process and analyze data at the atomic level [6]. Nano-biosensors open up new avenues for scientific science and offer resources for real-world bio-analytical applications that were previously unattainable. In combination with other methods, including lab on chip, they can be used to simplify molecular analysis. Its use involves the recognition and identification of metabolites and the detection of numerous micro-organisms and contaminants by analytes such as urea, glucose, toxins and others [7].

1.2 Features ofan Ideal Nano-biosensor:

- A sensor must be able to identify very precise for the purposes of research.
- There should be no impact on the basic contact between analytes on physical parameters such as stirring, temperature and pH.
- Response time to a minimum should be held.
- The outcomes should be valid, correct, repeatable and linear, free from electric noise and across the useful scientific continuum.
- An incredibly lightweight, biocompatible nanobiosensor, nontoxic and anti-induced should be available.
- Cheap, lightweight, and semi-skilled operators can perform better.

1.3 Constituents of Nano-biosensors:

The basic Nano-biosensor consists, as seen in Figure 1, of three elements: biologically sensitized, detector and transducer: Biologically sensitized components, including antibodies, receptors, molecular imprints, enzymes, lectins, micro-organisms, nucleic acids, tissue, organelles and other biologically derived or bio-imitative components, that accept and transmit signals from analytes. And such Nano-receptors may be essential for the progress of future Nano-biosensors [8].

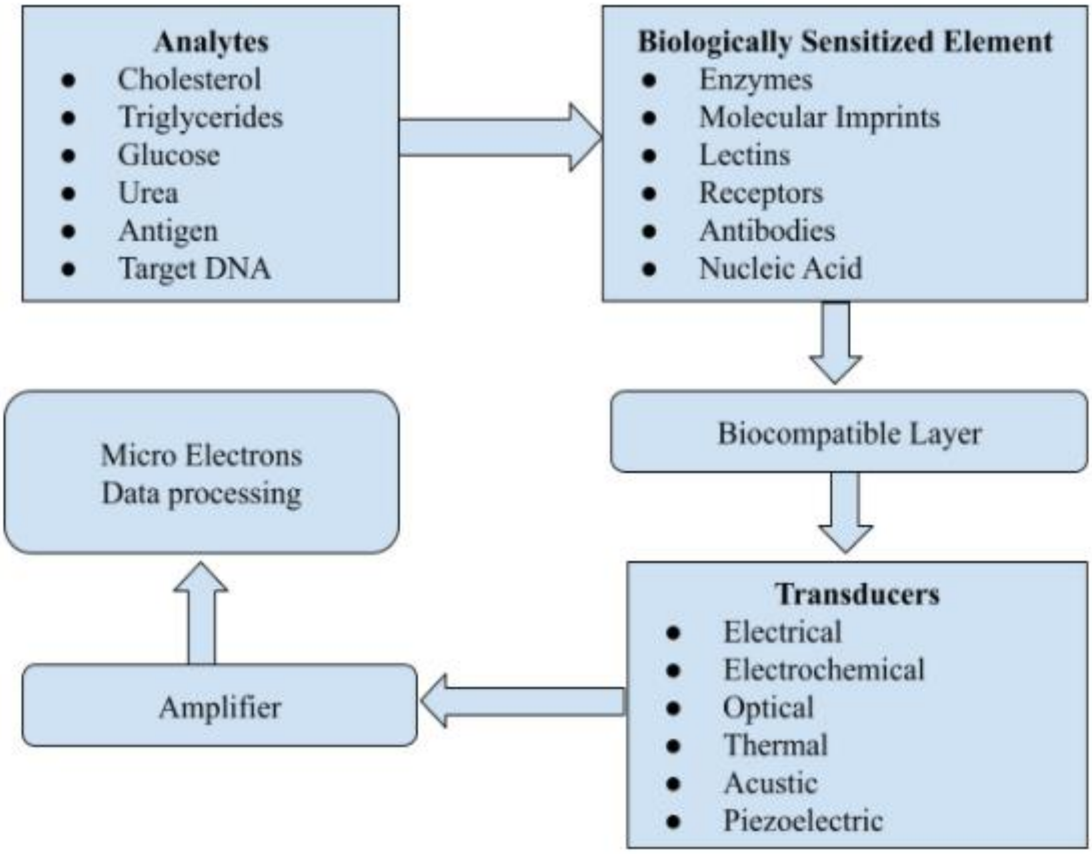

Figure 1:The Principle of Nano-biosensor.These nano-receptors are crucial in the growth of potential nano-biosensors.

The transducer serves as an interface to measure and turn the physical transition that happens in the biological responsive reaction into a measured electric production. The transducer can be divided into classes based on the mode of operation and carefully discussed (Table 1). The detector traps and amplifies and analyses the transducer's signals using a microprocessor; data are interpreted and easily displayed [9].

Table 1: The Principle and Applications of Various Transducer Systems.

S. No	Transducer System	Applications	Principle
1	Enzyme Electrode	Immunological System and Enzyme Substrate	Amperometric
2	Piezoelectric Crystal	Vapors and Volatile Gases	Mass Change
3	Conductometer	Enzyme Substrate	Conductance
4	Thermister	Organelle, Enzyme, Tissue Sensors or Whole Cell for Products, Substrates, Gases, Antibiotics, Pollutants, Vitamins, etc.	Calorimetric
5	Fiber optic and Wave guide device	Immunological System and Enzyme Substrate	Optical PH
6		Enzymes Substrates,	

	Field Effect Transistor	Gases, Ions and Immunological Analytes	Potentiometric
7	ION Sensitive Electrode	Ions in Biological Media, Enzyme Electrodes, Enzyme Immunosensors	Potentiometric

1.4 Advantages and disadvantages of nano-biosensors over conventional biosensors:

1.4.1 Advantages:

1. These devices are extremely sensitive, detecting single virus particles or extremely low amounts of a potentially dangerous material.

2. Nano-biosensors have the best performance at the atomic scale.

3. Nano-biosensors have elevated surface-to-volume ratio.

1.4.2 Disadvantages:

1. Nano-biosensors are extremely sensitive and vulnerable to errors.

2. Nano-biosensors are still in their infancy.

1.5 Types of Nano-biosensors:

1.5.1 Mechanical Nano-biosensors:

Nanoscale mechanical forces between biomolecules provide a fascinating platform for studying biomolecular interactions. This aids in the production of biosensors that are small, responsive, and label-free. Beams may be used to classify biomolecules by deflecting as they come into contact with one. The total sample analysis can be interpreted and quantified by calculating the degree of displacement of the each ray meeting in response to molecular interaction. Three methods are commonly used in order to turn interest analysis into micromechanical cantilever bending. Nano-mechanical instruments are advantageous because they are extremely mass adaptive. The size of the analyte molecules reduces, resulting in an increased relative shift in the main mass in order to include attached analyte molecules [10].

1.5.2 Optical Nano-biosensors:

Optical biosensors are used to circulate light streams in a closed direction by means of optics, with the difference in resonant also reported when the analyte is connected to the resonator. Light is bouncing in a linear resonator in a ring resonator between two end mirrors. In contrast to mechanical resonators, optical resonators are constructed inside a cavity on the light oscillation. Most market-based optical biosensors use lasers to detect and quantify biomolecule interactions on particularly derived biochips or surfaces. Surface Plasmon Resonance is a light-metal electro-optical electricity phenomenon. The energy has been transferred to a metal surface by light photons. High demand is met with mini-optical sensors that accurately detect low environmental and biological materials. An amazing optical function of a three-way silver nanoparticle with increased sensitivity to the atmosphere has been developed recently.

1.5.3 Nanowire Biosensors:

A nanosensor consists of a combination of two highly sensitive molecules: one-stranded DNA and one carbon nanotubes. By adding biological or chemical molecular ligands, the surface properties of Nanowires are rapidly modified to detach from analysts. This modifies the chemical binding event on the surface in a highly sensitive, real-time and quantitative manner. Highly sensitive sensors for organic and chemical species were developed in real time using boron-doped silicon nanowires.

1.5.4 Ion Channel Switch Biosensors:

These biosensors are founded on an electrical power-activating synthesis membrane which serves as a biologic switch to detect signals (specific molecular presence). It gives precise and quantitative real-world test results, cutting time from hours to minutes for identifying an emergency.

1.5.5 Viral Nano-biosensors:

Especially biological nanoparticles are virus particles. Andenovirus and Herpes simplex virus (HSV) were used as nanosensors for clinically important viruses to initiate the assembly of magnetic nanopercussions.

1.5.6 PEBBLE Nano-biosensors:

PEBBLE Nano-biosensors comprise of microemulsion polymerization sensor molecules, resulting in spherical sensors shaped 20 to 200 nm. Various sensor molecules such as optical transfer detection, pH or Ca2+ ions or fluorescence detection can be captured. They control the intracellular imagery of ions and molecules, although also insenient to protein interaction and demonstrate great reversibility and stability in laugh and photo-bleaching. These sensors can be used to detect ions and molecules in real-time. They display solid oxygen sensing capabilities in human plasma, least influenced by light dispersion and auto-fluorescence.

1.5.7 Nano-shell Biosensors:

Gold Nano-shells are used in a fast immune assay to detect analytes without the need to prepare a sample in complex biological mediums. The spectroscopy of antibody / Nano shell conjugates with extinction spectrums is conducted in the presence of analysis in the near-infrared. Nano-shells can make a factor of ten billion better than chemical sensing.

1.6 Nano-biosensor role in Agriculture:

Nanomaterial based biosensors now have exciting opportunities in comparison to conventional biosensors. Nano-biosensors have distinct benefits, such as increased identification specificity, and have vast potential for application in a variety of areas, such as bioprocess and environmental management, irrigation, food quality control, biodefense, and, most notably, medical applications. However, the nanobiosensors role in agriculture as well as agricultural products at this instance is point of interest. The Nano-biosensor has several possible applications:

1.6.1 As Diagnostic instrument for Disease Assessment and Soil Quality:

In solar diagnosis, uneven oxygen intakes of weak microbes and healthy microbes and are assessed. The diagnosis can also use this treatment plan. The protocol is as follows: the elements are impregnated by weak microbes and the other by strong microbes with an oxygen consumption of two microns, in the suspension of a soil sample in a buffer solution. It is easy to find out which microbe promotes the soil by comparing them. Furthermore, it is also possible to predict if soil disease is able to break down the soil. It should also be emphasized that the bio-sensor offers a novel system of soil diagnostics with a semi-quantitative approach.

1.6.2 Promoting Sustainable Agriculture:

A Nano-fertilizer contains nutrients stored and distributed to crops in a nanoparticle. Encapsulation exists in three forms: The nutrient is present in nanomaterials for example nanotubes, Nano-porous material which is covered with a polymer shield coating or isolated in emulsions or nanoscale. Both soil microorganisms can minimize nanofertilizers' leaching, emission and long-term absorption of nitrogen. Carbon nanotubes have recently penetrated the root tissue of ryegrass and nanoparticles of zinc oxide have been identified. This helps to create new nutrient supply structures that take advantage of porous nanoscale plant surfaces. However, the nano-fertilizer should demonstrate continuous on-demand release of nutrients and prevent them from premature transformation into chemical/gas forms which plants are unable to absorb. This can be achieved by attaching a bio sensor to this nano-fertilizer that enables the selective release of nitrogen related to the conditions of time, soil and atmosphere nutrient. Slow-controlled fertilizer releases will also boost the soil by reducing over application toxic effects linked to fertilizer. Zeolites natural crystalline aluminum silicones are present and can:

I. Improve the growth of plants;

II. Improve the quality and value of fertilizers;

III. To improve the penetration and retention of water;

IV. Rise in rates of return;

V. Preserve plant-based nutrients;

VI. Improving the condition of the soil over time;

VII. Mitigate soil degradation of nutrients.

Zeolite stores nutrients for use by plants in the root zone when they are required. The benefit of Zeolite treatment is that it does not degrade over time and therefore tends to improve mineral and water preservation forever, as opposed to other soil additives. Zeolite improves the ability of the soil to consume and produce nutrients in future applications. Since each of their plants or the soil is deficient and the release of Zeolite water or nutrients can be regulated, Zeolites paired with a nanobiosensor can modernize farm production.

Pesticides are being produced in nanoparticles that can be released on schedule or released in connection with an environmental stimulus. In addition, herbicides should only be used where required along with smart distribution systems, thus leading to more crop yield and less damage to farm workers.

1.6.3 Detection of Contaminants:

A number of Nano-biosensors have been developed for the identification of dryness, temperature or stress contaminants, pests, nutrient levels and plant stresses. They can also enable agriculturists to develop their skills only if necessary by using inputs. Liposome biosensors can detect organ phosphorus pesticides at very low levels such as dichlorvos and paraoxon. M. Bielaszewska et al. proposed a technique for detecting Escherichia coli with the help of adapted bismuth nanofilm founded on theory of analyzing flow injector [11]. The nanowell found minor voltage variations because the phages were bacteria immune and exhibited spectral strength [12]. PSII (photosystem II), which indicates that a variety of herbicides are related to photosynthetic plants, can be constructed with the ability to monitor contaminating chemicals and create low-cost user-friendly equipment to detect particular herbicides as well as an extensive organic compounds in industrial and urban pollutants.

1.6.4 Detection of Protein and DNA:

There are several sensors for the Nano-sensor of DNA oligonucleotides, such as the ssDNA-CND/Biosensor, the ssDNA samples for the detections of different DNA sequences, the GCE-modified MWNT/ZNO/CHIT compound for immobilization, the Nano-biosensor with the chitosan MWNT composite layers to effectively discriminate between the DNA samples and the SPCE for the detection of dedicated DNA damage. Maki et al. have published the first transistor-based Nano-wire field effect biosensor that clearly and ultra-sensitively identifies electronic DNA methylation with no need of complex bisulfite therapy or an amplification of PCR.

Protein-nanoparticle-based biosensors can also achieve ultra sensitive identification of special protein molecules by the use of protein linkage-interaction propensities. These biosensors can be useful for the detection of plant parasites, plant defects, biomarkers and for distinguishing between one plant species and another.

1.6.5 Analyzing the Food Products:

A research based on Biosensor is gaining popularity within the food industry, in which it can be used in a variety of ways:

1. *Analysis of Vitamin:* The SPR biosensor measures the association of an immobilised vitamin with a specific binding protein in a CM5 sensor.

2. *Detection of Antibiotics:* Banned antibiotics were recently discovered in honey. Biosensors accurately, effectively, and quickly detect the presence of antibiotics.

3. *Microbial Infection Detection:* Immuno-biosensors which depend on the monoclone antibodies immobilization onto indium tin oxide electrodes are capable of detecting E. coli O157:H7.

Discussion

In order to generate an electric signal proportionate to one analyzer that is then passed to a detector, the biological sensor is combined with a Physiochemical transducer. Agriculture's access to net land and water supplies is increasingly dwindling, resulting in massive losses in agricultural production. These problems can only be solved effectively with the help of emerging innovations, which are constantly being developed. Nanotechnology is currently seen as a rapidly developing area with the ability to transform the agricultural system. A nano-biosensor is typically constructed on the nanoscale to collect, store, and interpret data at the atomic level. A broad range of herbicides, fertilizers, pesticides, insecticides, bacteria, pH-soil and moisture can be detected, by Nano-biosensors. Nano-biosensors can boost crop productivity when properly and in a controlled way.

Conclusion

Within the sensor culture, there is a strong desire to improve the capacity for real-time sensing. Through developing screening methods, nanotechnology has the potential to have a significant effect on the economy, energy and the atmosphere. Innovative possibilities for incorporating nanotechnologies into nano-biosensors should be investigated, while keeping in mind any possible risks to the atmosphere or human health. We believe that nanotechnology will transform agriculture by focusing on research and development with a strong commitment from policymakers and academics to sustainable agriculture. Nanotechnology has the ability to create a huge affect on economy, climate and resources by improving screening methods. There should be a discussion of new ways to use nanotechnologies in Nano-biosensors, taking into account any potential atmospheric or human health hazards. It is anticipated that nanotechnology will transform agriculture by concentrating research and development on the goal of achieving high productivity in agriculture and by specifically supporting the development of high quality agro-products by scholars and governments

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