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The Application of Nano-biosensors in Farming Sector

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ABSTRACT

Nanotechnology has emerged as a gift for mankind in a variety of areas of research and everyday life with huge potential. The application of nanotechnology in the creation of bio sensors results in a very effective Nano-biosensor with a tiny structure compared to conventional biosensors. nano sensors and smart delivering Nano-dynamic systems may be used to monitor the discharge of pest and pathogenic agrochemicals, to identify plant virus, to detect soil nutrient level, and to release slow-release Nano-encapsulated fertilizer, without losing it via leaching. Consequently, there is great optimism that such robots may support agriculture by boosting output and productivity. In a wide variety of areas of research and in our everyday lives, nanotechnology has emerged as a gift for mankind. Because nanotechnology is utilized to improve biological sensors, it produces a more robust Nano-biosensor with a smaller structure. A wide variety of fertilizers, herbicides, pesticides, insecticides, microorganisms, moisture and soil pH may also be detected using Nano biosensors. Nano-biosensors may assist promote sustainable agriculture and improve crop production when utilized correctly and in a controlled way.

Keywords

Agriculture, Herbicides, Nano-biosensors, Nano-Fertilizer, Pesticides.

1. INTRODUCTION

Agriculture's access to total land and water resources is decreasing, leading to significant losses in farm output. In addition, increasing levels of herbicides, pesticides and heavy metals are also affected in farmland. These challenges can only be dealt with effectively with the aid of emerging technologies and a continual input of emerging innovations into this business. Nanotechnology is presently recognized as a fast-paced discipline that offers tremendous potential for transformation of agriculture and food systems. It is seen as a possible instrument for boosting the quality of agriculture goods and natural resources. It may strengthen the farming industry by fostering sustainable manufacturing,
reducing agricultural prices and boosting commodities value[1].
This article analyses Nano-biosensors' role in assisting farming in order to feed the increasing global population, given the present scenario and the advantages of nanotechnology. On the basis of components, pH, the microbial load, humidity, as well as other variables, Nano-biosensors may be very helpful for assessing soil quality and are therefore an essential means of enhancing productivity.
A Nano-biosensor is a modified form of a biosensor which is a tiny analytical or biological sensitized system and a physic-chemical transducer. The Nano-biosensor is a biosensor. The first biosensor was developed in 1967, and several other biosensors were invented. Since the early 20th century, bio-sensors have been available, but their uses are confined to laboratories.
Many novel biosensors have been created as technology progresses. There are three 'generations of biomedical sensors; electric biosensors operated in the first generation; biosensors functions between the reaction and transducers in the latter generation involving specific 'mediators;' and the biosensors themselves in the third generation do not have any impact on the product or mediator diffusion[2].

1.1 Nano-biosensors

Nano-biosensors with excellently specialized tiny sensors and great miniaturization have been designed and developed using nanotechnology concepts in the 21st century. Researchers have created biosensors that combine Nano science, electronics, computers, and biology with unequalled spatial and temporal accuracy and endurance. Nano-biosensors are Nano-sensors which are selective for the target analytic molecules, using immobilized bio-receptor samples.
A Nano-biosensor is normally built to collect, save and analyze atomic data on the Nano scale. Nano-biosensors bring up new possibilities for the sciences and provide resources for hitherto unachievable bio-analytical applications in the real world. In combination with other instruments, such as a laboratory on a chip, they may be utilized to facilitate molecular research. Identification of analytics such as urea, glucose, toxins and other compounds, metabolite control and the recognition of various micro-organisms and pathogenic agents are their purposes[3].

1.2 Ideal Nano-biosensor Features

- A sensor must be able to identify very specific for analyses.
- A highly sensitive sensor must be able to distinguish between the analytic and some "other" material for the purpose of measurements.
- The particular interaction between analytics should not be affected by certain physical factors such as stirring, pH, and temperature.
- Response time should be maintained to a minimum.
- The findings should be trustworthy, accurate, recurring and linear across the relevant empirical spectrum and electric noise-free.
- A very tiny, biocompatible, nontoxic and antigenic Nano-biosensor.
- Semi-skilled operators should be cheap, small and appropriate.

1.3 Nano-Biosensor Constituents

Three components comprise the typical Nano-biosensor: physiologically sensitized elements (sample), transducer and detector: Biologically sensitive elements (sample), comprising enzymes, receptors, nucleic acids, molecular imprints, antibodies, tissues, lections, organs and other biologically

generated or bio-imitative elements, which receive and transmit signals from analytics (sample) of interest. And such Nano-receptors are important for growth of future Nano-biosensors.
The transducer works as an interface for monitoring and translating the gender reassignment in the physiologically sensitive reaction into a quantifiable electrical production. Depending on the way of action, the transducer might well be categorized into four classifications and researched in depth. The sensor element catches the signals of the transducer that is amplified and processed via a microcontroller and then converts the data into a user-friendly output and displays/stores it [4].

1.4 Nano-Biosensor Benefits and Drawbacks

1.4.1 Advantages

- These gadgets are highly vulnerable to individual virus particles or extremely tiny quantities of a potentially hazardous substance.
- Nano-biosensors offer the best atomic scale performance.
- There are also greater surface-to-volume ratios between Nano-biosensors.

1.4.2 Disadvantages

- Nano-biosensors are very susceptible.
- There are still Nano-biosensors in their infancy.

1.5 Nano-Biosensor Types

1.5.1 Nano-Biosensors for Mechanical Purposes

The mechanical Nano scale between biomolecules offers an interesting environment for investigating bimolecular interactions. This helps in the development of compact, responsive and label-free bio-sensors. Beams may be used to categorize biomolecules when they come into contact, by deflecting them. By determining the degree of deflection each cantilever beam experiences may be measured and understood by computing the total of the analysis inside the solution. Generally, the identification of the analytic of interest is converted by three techniques to the micromechanical cantilever bending. Because they are very mass adaptable, Nano-mechanic instruments are useful. As the size of the analytic molecules reduces, the mass lowers, which leads to a greater proportionate change in the major mass in the inclusion of connected analytic molecules[5].

1.5.2 Nano-Biosensors Optical Application

Optical biosensors work by using optics to cycle a beam in a closed route, with the change in resonation frequency recorded whenever the analytic attaches to the resonator. Light bounces across two end miracles in a linear resonator, and light bounces between two end mirrors in a circular resonator. Unlike mechanical harmonic resonance, optical repeaters rely only on light oscillations within the hollow.
The majority of commonly produced optical biosensors use lasers to detect and measure biomolecule interactions on specially designed surfaces or biochips. SPR is an optical-electric phenomenon that involves light interacting with metallic electrons. Photons of light just on surface of steel transmit energy to a group of electrons (a Plasmon). Miniature optical sensors that can detect trace amounts of genetic and environmental substances are in great demand. A hexagonal silver nanoparticle with remarkable optical properties and heightened sensitivity to its surroundings was recently produced [6].

1.5.3 Biosensors Nanowire

The Nano-sensor is a blend of two molecules extremely sensitive for external signals: a single-stranded DNA (the "detector") and a carbon nanotube (the "sensor") (serving as the transmitter). The surface characteristics of nanowires may be rapidly altered by adding chemical or biological molecule ligands, making them independent from analysis. This transforms the chemical binding event on its surface into a very sensitive, real time and quantitative change in nanowire conductance. Highly sensitive electrically dependent sensors were developed for biological and chemical organisms using boron-doped silicone nanowires (SiNWs).

1.5.4 Biosensor Technologies Ion Channel Switch

The Ion Channel Switch (ICS) is based on a synthetic self-assembling membrane, which serves to activate electrical currents as a biological switch to detect signals. It delivers accurate and quantitative test results in real time and cuts the time required to detect an emergency from hours to minutes.

- Electronic Nano biosensors: electronic Nano-biosensors detect the binding of the target DNA which, via electronics, creates a bridge between two wires on a microchip. Each chip contains multiple sensors that may be handled individually for distinct target DNA molecules of the same or different species with capture samples.
- Nano-viral sensors: Particles of the virus are especially biological nanoparticles. Herpes simplex virus (HSV) and adenovirus were utilized as Nano sensors to start the construction of magnetic Nano-percussion for clinically significant viruses.
- Nano-biosensors PEBBLE: PEBBLE Nano-biosensors are composed of sensor molecules enclosed by micro-emulsion polymerization in a chemically inert matrix resulting in spherical sensors in diameters ranging from 20 to 200 nm. Different sensor molecules, such as those detecting optical transitions, pH, or $Ca2+$ ions, or those detecting fluorescence may be trapped. They regulate the intracellular imaging of ions and molecules but also are essential for protein interaction and show remarkable reversibility and stability during laughter and photo-blinding. These sensors may be used in real-time to detect ions and molecules. In human plasma, they show solid oxygen sensing capability, which is less affected by light dispersion and auto-fluorescence.
- Biosensors Nano-shell: Golden Nano-shells are employed in rapid immunoassay to identify analytics without sample preparation in complicated biological conditions. In presence of analytics, the antibody/Nano-shell conjugates with extinction spectra are monitored in near-infrared. Nano-shells can enhance the sensing of chemicals by 10 billion fold.
- Agriculture Nano-biosensor role: Biosensors based on nano material's are now interesting compared to traditional biosensors. Nano-biosensors have unique advantages, such as enhanced sensitivity and specificity to identify and provide tremendous potential for use in many sectors such as environmental and bioprocess management, food quality control, irrigation, biodefense and, in particular, medicinal applications. In this instance, however, we are interested in the function of Nano-biosensors in agriculture and agro-products[7].

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- As Soil Quality and Disease Assessment Diagnostic Tool: The quantitative assessment of the difference in oxygen intake (relative activities) in the ground from "good microorganisms" versus "bad microbes" is important in the diagnosis of soil disease. The procedure is as follows: two electrodes, one loaded with 'positive microorganism' and the other with 'poor microbes,' are submerged in a soil sample suspensions in a buffer solution, and data on oxygen intake from two bacteria is calculated. It is easy to identify what microorganism improves the soil by comparing two data. Furthermore, we can also anticipate if soil disease is ready for soil breakdown. The bio-sensor offers a semi-quantitative approach to the new technique of soil diagnosis.
- As a Sustainable Agriculture Promotion Agent: A Nano-fertilizer is a substance containing and transmitting nutrients within a nanoparticle. Encapsulation may be carried out in three ways: The nutrition may be embedded in nano material's such as nanotubes or Nano-porous materials, covered with a thin protective coating or dispersed as tiny particulate matter or emulsion. Leaching, emissions and long-term absorption of soil microorganisms using Nano-fertilizers may all be decreased. Recently carbon nanotubes have been found to penetrate tomato roots and nanoparticles of zinc oxide have been shown to enter the root tissues of ryegrass. This implies that novel distribution systems for nutrients may be developed to benefit from porous Nano scale areas on plant surfaces. The Nano-fertilizer should, however, show a constant release of nutrients on demand and prevent them from premature transformations into chemical/gas forms that plants cannot absorb. This may be done by connecting a bio-sensor to this Nano-fertilizer to selectively release the nitrogen associated with time, soil and nutrient atmospheric conditions. Slow-controlled releases of fertilizers will help improve the soil by minimizing harmful effects associated with fertilizer over application[8].
- Zeolites are natural crystalline aluminum silicates that are able to: a) enhance plant growth; b) increase efficiency and value of fertilizer; c) increase water pathway and retention; d) increase yield; e) maintain plant nutrient use; f) increase the quality of the soil for the long term; and g) minimize the depletion of the nutrients in the soil. Zeolite stores nutrients for use by plants in the root zone when they are needed. Thus, N and K fertilizer are more effectively utilized either with a lower yield or with the same fertilizer amount that lasts longer and yields higher. Another benefit of Zeolite treatment is that it is no longer degraded over time and thus helps to improve the nutrient and water conservation forever, in contrast with other soil additions (gypsum and lime). Zeolite may improve the capacity of the soil to absorb nutrients and produce better yields for future applications. In that the biosensor can detect any deficit in plants or soils and control water and nutrient flow from the Zeolite, Zeolites associated with a Nano-biosensor are capable of modernizing agriculture.
- Nanoparticles that are freed on time or released in conjunction with an environmental stimulation generate pesticides. Furthermore, herbicides should be applied just when necessary coupled with intelligent distribution methods, resulting in increased crop production and reduced harm for farmers.

1.6 Contaminants as a Detection Factor

A number of Nano-biosensors have been created to detect droughts, temperature, or strains toxicity, pests, nutritional content and plant stress. They may also assist farmers develop their skills solely by utilizing inputs when they are absolutely required. Liposome-based biosensors may detect extremely low amounts of organ phosphorus herbicides, such as dichlorvos and paraoxon. Zhang et al. devised a method for the detection of escherichia coli (E. coli) using bismuth Nano film modified GCE based on the idea of flow injections analysis (FIA). Researchers developed a biochip sensor system with two ti touch pads and a 150 nm Ti Nano well unit on a LiNbO3 substratum. Small voltage changes were seen in Nano wells when bacteria were immune to the phages (uninfected bacteria) (PSD). PSII (Photosystem II) biosensors, which have shown to link many herbicide groups insulated from photosynthetic organisms, can monitor contaminating substances, lead to the development of a cost-effective, easy-to-use apparatus for detecting specific herbicides and finally a wide range of organic compounds in industrial and urban effluents[9].

1.7 Tool for Effective DNA and Protein Detection

There are a number of Nano-composite sensors such as ss DNA-CNTs / optical biosensors for the detection of particular types of DNA oligonucleotides, MWNTs/ZnO/ChIT Composite Film GCE modified for ss DNA samples for the efficient discovery of various DNA sequences, Nano-biosensors for the sensing of deep DNA damage with bio Nano-composite layer MWNT in chitosan Maki et al. have presented a first nanowire effect transistor-based biosensor which clearly and very sensitively detects electronic DNA methylation without the requirement for complex bisulphite treatment or PCR amplification.

Biosensors based on protein-nanoparticles may also get a very sensitive identification of certain protein molecules by utilizing the characteristics of interaction of protein-ligand (antigen). These biosensors may be helpful for the detection of plant parasites, plant abnormalities due to mineral shortage, biomarkers and the distinction between one plant species and another species[10].

1.8 Product Analysis Tool

Biosensor based research in the food sector is gaining prominence in a number of ways:

- Vitamin testing: The SPR biosensor monitors the interaction of a specific binding protein with the immobilized vitamin on a CM5 sensor unit.
- Detection of antibiotics: Recently banned drugs have been found in honey. Biosensors detect the presence of antibiotics precisely, efficiently and rapidly.
- Detection of microbial infections: E. coli O157:H7 is detected using immunobiosensors reliant on surface immobilization of mono clone antibodies on indium tin oxide (ITO) electrodes.

2. DISCUSSION

The biologic element is combined with a physiochemical transducer to produce an electrical signal corresponding to a single analyzes that is then sent to a detector. Access to net land and water resources by agriculture is declining, leading to significant losses in agricultural output. These issues can only be resolved successfully with the assistance of continuously developing new technologies. Nanotechnology is now regarded as a fast growing field capable of transforming the farming system. Typically, a Nano-biosensor is designed on the nano scale to collect, store and analyze atomic data. A wide variety of fertilizers, herbicides, pesticides, insecticides, microorganisms, moisture and soil pH may also be detected using Nano-biosensors. Nano-biosensors may improve agricultural production if utilized properly and in a controlled way.

Nanotechnology is essentially concerned with the tiniest particles that play a significant role in resolving issues that cannot be addressed by current methods in agriculture. New uses in agriculture are shown in the production of new nanomaterials and Nano-devices. The creation of better biosensors leading to the development of tiny structures called as Nano-biosensors is one of the uses of nanotechnology, which are more efficient and well organized than conventional biosensors. Nano biosensors for the sensation of soil pH, moisture, a broad range of pathogens, hormones, plant metabolites, pesticides, herbicides, fertilizer and metal ions may be utilized successfully in agriculture. Suitable and regulated usage of Nano-biosensors may help sustainable farming to improve crop yield. It can also assist to limit the usage of agricultural inputs by controlling pollution and reducing farming costs.

3. CONCLUSION

There is a significant demand in sensor culture to enhance the capability for real time sensing. By developing screening procedures, nanotechnology seems to have the potential to be a great influence on energy, the economy, and the environment. New approaches for incorporating nanotechnology within Nano-biosensors should have been investigated while considering any possible dangers to the environment or human health. We anticipate nanotechnology to revolutionize agriculture by focusing research and development on sustainable agriculture with an emphasis on government and university initiatives to create such agro-products. Nanotechnology does have the possibility to have a substantial influence on energy, the environment and economy through the advancement of screening procedures. New options for the inclusion of applications of nanotechnology into Nano-biosensors must be studied, taking all possible hazards to the environment or people's health into consideration. We anticipate nanotechnology to transform agriculture by concentrating research and development on sustainable agriculture, with focused efforts by governments and academia to create such enabled agricultural goods.

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