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An Overview on Use of Biosensor in Agriculture

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ABSTRACT
The biosensor are the analytical instrument that transforms biological reactions into electrical signals. They include tissue-based enzyme-based, DNA biosensors, immune-sensors, piezoelectric, thermal, and biosensors. Biosensors may be utilized in a number of agricultural applications, such as assessing toxins in soils and crops, detecting and diagnosing infectious illness in crops and animals, on-line monitoring of key food process parameters, measuring animal reproduction, and screening for veterinary drugs. This article investigates biosensors, their kinds, and their applications. This paper also discusses agriculture and the application of biosensors in agriculture, among other topics. To make cell and tissue-based biosensors, genetically engineered proteins are injected into cells ex vivo or in vivo. They allow the researcher to constantly and noninvasively detect levels of hormones, medicines, or poisons using bio photonics or other physical principles. In this regard, the spectrum may be useful in the field of aging research in the future.

Keywords
Agriculture, Biosensor, Enzyme, Sensor, Tissue.

1. INTRODUCTION
Analytical device that can transform the biological reactions into an electrical signals can be described as biosensors. Biosensors should be very precise, reusable, and independent of physical variables like pH and temperature. Engineering, chemistry, and biology are all used to research biosensors, their designs, transducing processes, and immobilization methods. Biosensor materials are classified into three categories based on how they work. Enzyme biosensor have been developed using immobilization methods such as Vander Waals powers covalent bonding or ionic bonding. Some of the most often utilized enzymes for this purpose include oxidoreductases, polyphenol oxidases, peroxidases, and amino oxidases.
The analyte of interests may be process's inhibitor. However, although this kind of biosensor had a high level of stability, the detections time was more longer& specificity decreased. Immunosensor is high empathy for antigen, which means they respond precisely to infections or metabolites, or interfere with immune system. Deoxyribonucleic acid biosensor function because single-strand nucleic acids molecules may recognize and attach to their corresponding strand in a sample. The presence of stable hydrogen bonds between two nucleic acid strands causes their connection. Magnetic biosensors, which are tiny biosensors that monitor magnetic micro and nano particles in microfluidic channels using the magnetoresistance effect[1,2].
As previously stated, a thermal biosensor, also known as a calorimetric biosensor, is produced by integrating biosensor material with physical transducers. Two types of piezoelectric biosensors are quartz crystal micro balance. They rely on the computation of changes in a piezoelectric crystal's resonance frequency as a consequence of crystal structural changes. A light basis and a number of optically manufactured components work together for creating light beam properties & guide it toward a moderating agent in an optical biosensor. The discovery of green fluorescent proteins and later Auto Fluorescent Proteins variant & hereditary fusion reporter has aid development hereditarily encode biosensor. Building, manipulating, and implanting this kind of biosensor into cells is straightforward. They're made up of a pair of AFPs that, when placed close together, may transfer fluorescence resonance energies.
Different methods of controlling advances in FRET signal may be used depending on the size. Peptide & protein biosensor are made via synthetically chemistry and then enzymatically tagged with synthetic fluorophores. Because they are not reliant on genetic encoded AFP, Simple to monitor target behavior and make appealing alternatives. By adding chemical quenchers and photoactivatable classes, they may also enhance the signal to noise ratio and compassion of the process. Agriculture is the study, skill, and discipline of raising plants and animals. Agriculture was a key step in the rise of sedentary human civilization because it allowed humans to dwell in cities by producing food surpluses from tamed animals. Agriculture has a long and illustrious history that dates back thousands of years.
Though approximately 2 billion people still rely on agriculture, industrial agriculture based on large-scale monoculture began to dominate agricultural output in the twentieth century. Plant propagation, modern agronomy, agrochemicals such as fertilizer and insecticides, and technical advances all contributed to significantly higher yields, which wreaked havoc on the environment. Environmental issues include climate change, groundwater depletion, deterioration, antibiotic resistance, and the use of growth hormones in commercial meat processing. Agriculture is also especially susceptible to environmental deterioration, such as habitat loss, desertification, soil degradation, and global warming, all of which reduce agricultural yields. While some nations have outlawed the use of genetically modified organisms, they are extensively utilized in others[3,4].

2. LITERATURE REVIEW
Suresh Neethirajan et al. discussed the increasing human population, the maintenance of clean water and food quality, and the conservation of the climate and environment all offer major difficulties to current food production. Food security is mostly a joint effort combining both public and private sector technological development. Several attempts have been made to solve issues and enhance food processing drivers. Biosensors and biosensing instruments, as well as their implementations, are often utilized to solve some of the most urgent food processing and sustainability problems. As a consequence, biosensing technology is becoming more important in the area of food sustainability. Microfluidics is a kind of technology that integrates many technologies. Nanomaterials, with their biosensing technology, are seen to be the most promising approach for solving global health,

energy, and environmental issues. Analytical instruments that are quick, convenient, reliable, small, and low-cost are in high demand for Point-of-Care (POC) technologies in the field. This research looks into biosensing for food production, food distribution, food safety and protection, food packaging and supply chains, food waste processing, food food engineering, and quality assurance. The current level of knowledge on biosensor creation, solutions, and possible issues, as well as biosensor commercialization, is summarized[5].

Maria N. Velasco-Garcia et al. conducted research. Biosensor technology is a strong alternative to conventional analytical methods because it leverages the sensitivity and specificity of biological systems in lightweight, low-cost sensors. Despite potential biosensors being developed in research laboratories, there are few examples of agricultural monitor applications. The author investigates biosensor technology, as well as different bio receptor mechanisms and transduction processes. The differences between biosensor and fully integrated biosensor systems are discussed, as well as the main reasons for the slow adoption of biosensor technology. Environmental technologies, health care, and the food sector are the main focus of developing biosensor research. Hand-held glucose meters for diabetics are the most economically viable use. In the agricultural/veterinary research sector, there have been a range of diagnostic tests, but no genuine biosensor system has had a full effect. Because of the need for quick, accurate sensing and on-line, biosensors can be used for in-situ examination of contaminants in soils and crops, identifications of infectious disease in crop livestock and detection, on-line measurement of essential foods processing parameters, tracking animal fertilities, and screening therapeutic drugs in veterinary tests. Future challenges in the commercialization of biosensors are also addressed[6].

J.S. Rana et al. conducted research. The biochemical structure of food determines a lot of its substance. As a consequence, this research highlights current advances in the production of different kinds of Biosensors for the computation of various components in horticultural samples. Electrochemical, calorimetric, optical, and immunological sensors, as well as screen-printed three-electrode devices, are all under consideration. Glucose, fructose, malic acid, pyruvic acid, ascorbic acid, glycerol, glutamate, and other sugars are provided as examples[7].

ParikhaMehrotra discussedbiosensors of many types, such as tissue-based, enzyme-based immunosensors, Deoxyribonucleic acid biosensors, piezoelectric, and thermal biosensors, have been addressed to show how important they are in a number of fields. Biosensors are used in the food industry to track consistency and protection, as well as to distinguish between artificial and natural ingredients; biosensors are used in the scarification process to detect specific; metabolic engineering and glucose concentration use biosensors to allow in-vivo monitoring of cellular metabolisms. Biosensors, as well as their applications in medical research, such as early detection of human interleukin 10, which causes heart disease, and rapid detection of the human papillomavirus, are important considerations. Drug development and cancer research need fluorescent biosensors. Biosensor applications are often utilized in plant biology to detect missing links in metabolic processes. Other uses include defense, the therapeutic market, and marine applications[8].

3. PRINCIPLE AND TYPES OF BIOSENSOR

The biosensor works on the principle of signal transduction. Biorecognition elements and electrical systems consisting of a display, amplifier, and processor are among these components. Investigative chemistry plays a significant part in food quality parameters since virtually every business and government function relies on quality control. A food quality biosensor is a device that detects and converts one or more food characteristics into visual signals, most often electric impulses. This signal may possess exact knowledge of the quality factors to be computed, or it may have a pre-existing connection with the quality factor.

3.1. Electrochemical Biosensors

An electrochemical biosensor is a kind of sensor that converts biological events into electrical impulses. In that kind of sensor, the electrode is a critical component, acting as a robust support for biomolecule hold and electron flow. Thanks to different nanomaterials with large surface areas, synergic effects are enhanced by improved loading capacity as well as mass transportation of reactants for achieving high efficiency in terms of analytical sensitivity. Electrochemical biosensors are biosensors that work with the help of an electrochemical transducer. Hormones, entire cells, complex ligands, and tissues are among the biological and nonbiological things that they can monitor. The produced signal may be converted into one of two types of signals: Potentiometric and amperometric biosensors are both available[9].

3.2. Biosensors using Potentiometric

This is reliant on detecting potential of system's electrodes in to precise references electrodes in the absence of current flow. In the method, potentiometric measurements in the test sample are connected to analyte behavior. The potentiometric biosensor of detecting of concentrations (typically many order of magnitudes). Potentiometric biosensors haven't seen as much application in food safety testing as amperometric sensors. Only a few instances of how this method has utilized for the food quality studies including determining activities in apples juice, estimating sucrose concentrations, evaluating.

3.3. Biosensor using Amperometry

The most widely reported electrochemical technique in signal transduction is amperometric biosensors. A wide range of target analytes may be tracked using commercially available "one shot" sensors and on-line) equipment. Unlike amperometric instruments, the theory function of an amperometric biosensor is defined by a constant voltage applied between the working and reference electrodes. Redox reactions take place as a result of the increased potential, enabling a net current to flow. The amplitude of this current is related to the amounts of electroactive species present in the test solutions, and both the cathode (reducing) and anode (oxidizing) reactions may be monitored perimetrically. Enzymes are used as a biorecognition component in the bulk of the amperometric biosensors described. Typically, oxidase and dehydrogenase enzymes have been employed as catalysts in these biosensor forms.

3.4. Calorimetric Biosensors

In both chemical and biological processes, heat is transferred. As a consequence, calorimetric-based biosensing devices have benefited from the fundamental idea of heat production and absorption resulting from all biological processes. Heat absorptions or processing are involved in the majority of biological processes. Sensors based on calorimetric transduction are intended to detect heat generated or consumed during a biological process by using responsive heat detection equipment. Biosensors have been created for a range of target analytes. In the area of food quality analysis, this biosensor has been discovered as a tool for detecting metabolites[10].

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3.5. Optical Biosensors

These sensors assess how people respond to illumination or light pollution. Some of the methods used in optical biosensors to detect the presence of a target analyte include fluorescence, chemiluminescence, phosphorescence, photo thermal processes, light absorbance, surfaces plasmon resonances (SPR), light rotation and polarization, and total internal reflectance. This technique is used, for example, to detect the presence of allergens, particularly peanuts, during the preparation of food.

3.6. Acoustic Biosensors

Acoustic or mechanical waves are utilized to gather medical, biochemical, and biophysical information about the analyte of interest in acoustic wave biosensors. It detects changes in mass, elasticity, conductivity, and dielectric characteristics caused by mechanical or electrical forces. Changes in mass at crystal surfaces may affect piezoelectric quartz crystals; this phenomenon has been successfully explored and used to the development of acoustic biosensors. For functional applications, the surfaces of crystals may be altered with identifying components that bind directly to the target analyte.

3.7. Immuno-sensor

Immuno-sensors are solid-state devices that bind to a transducer through an immunochemical response. Because, like immunoassays, they rely on antibodies to detect antigens and create a stable complex, they are one of the most significant types of affinity biosensors. Immunosensors operate by using the specific interactions that exist between antibodies and antigens. Labels are often used in immunoassays to monitor the immunological response. The combination of a biosensor platform with an immunoassay format enables for quick and accurate quantitative measurements of the target analyte.

4. BIOSENSING TECHNOLOGIES AND FOOD SUSTAINABILITY

The concentration of molecules of interest (targets) in a sample is measured using a biosensor, which is an analytical device. It typically comprises of a target-specific biorecognition component (antibody, enzyme, or aptamer, for example). Molecule recognition events between the recognition factor and target chemicals generate physiochemical or biological signals, which are converted into an observable quantity by the transducer. Signals that are either optical (chemiluminescence, fluorescence, and surface plasmon resonances calorimetric) or electrical (voltammetry, capacitance, and impedance).

Biosensing technologies that solve all five of the aforementioned issues are becoming more important in the area of food sustainability. One of the challenges is the development of new energy sources, since present reliance on fossil fuels has limited their availability, possibly resulting in emissions. Bio electrochemical systems (BES) are being developed to solve the energy issue via the study of renewable energy sources, chemical processing, resource recycling, and waste remediation. These one-of-a-kind devices convert chemical energy to electrical energy in both directions by using microbes as catalysts recovered from organic wastes such as lignocellulosic biomasses and low-strength wastewater. The devices may be constructed to create electrical energies that can be utilized to produce hydrogen, peroxide, and caustic, as well as recycle metals and nutrients and remove refractory chemicals.

New concepts and innovative designs have been applied to unique separators, electrodes, and catalysts. One of the most significant issues in food production is deforestation, which is caused by increasing urbanization, industrialisation, global land depletion, and inefficient land use. In the past several decades, land loss has increased to 12.2 billion hectares, affecting 1.6 billion people. On the other hand, bioremediation, while a potential method for recovering degraded and polluted soil, may have certain field limitations. New biotechnology breakthroughs, such as the use of high-precision enzymes, the production of microbial consortia, and the use of plants as collaborators with microbials, are encouragingly leading to new paths in sustainable land regeneration. Land regeneration initiatives must be connected to additional benefits such as agricultural bioproducts, soil carbon sequestration, biomass materials, and biofuel, and restoration measures must be contaminant and site specific to meet societal circumstances and soil relevant regions. Biosensors with electrochemical impedance spectroscopy, which calculate current response as frequency using a small amplitude Alternating current voltage in the sensing electrodes, have been widely used in sustainable food processing.

Because of their all-electrical architecture, impedance biosensors may be integrated into small sensors for environmental monitoring and research. Impedance biosensors, for example, have been developed to detect BDE-47 and norfluoxetine, two endocrine disrupting compounds having detection limits of 1.4 and 8.4 ng/mL, respectively. While academic research on impedance biosensors have been substantial, commercialization has been hindered by a variety of factors, including the difficulties of impedance sensing, biomolecule immobilization stability, smaller analytics, and nonspecific absorption susceptibility. Figure 2 depicts the many kinds of bio-electrochemical structures (BESs). Global land depletion is one of the most serious problems in the food supply because of increasing urbanization, industrialisation, erosion, and unsustainable land usage. In the past two decades, global soil erosion has increased to 12.2 billion hectares, impacting 1.5 billion people. Bioremediation, on the other hand, has many potential field problems as a practical technique for repairing damaged and polluted soil. New biotechnology breakthroughs, including as the use of high-precision enzymes, the creation of microbial consortia, and the utilization of plants with microbial partners, are pointing to new possibilities for long-term land regeneration. Land regeneration activities must be linked to other benefits such as agricultural bioproducts, biofuel and wood materials, and soil carbon sequestration norfluoxetine, with detection limits of 1.4 and 8.6 ng/mL, respectively. While academic research on impedance biosensors has been substantial, commercialization has been hindered by a variety of issues, including the difficulties of impedance detections, biomolecule immobilization stability, smaller analytes, and nonspecific absorption susceptibility.

5. BIOSENSOR FOR FINDING AND IDENTFICATION OF INFECTIOUS DISEASES IN CROPS IN AGRICALTURE

Pathogens are microorganisms that infect crops and cause disease in large numbers. Bacteria and fungus are among them. Aflatoxin generation and fungal infection may happen at any time throughout the harvesting, plant development, drying, storage, or refining process. Aflatoxin exposure, whether via ingesting or inhalation, may cause serious medical problems (structural and functional damage of the liver, hepatic encephalopathy, immunosuppression, lower respiratory infections, gastrointestinal haemorrhage, anorexia, malaise, fever). Aflatoxin levels in animal feed and other foods are carefully monitored and regulated by federal authorities in the United States. Typically, 20 ppb action criteria are utilized to remove human food products from the market. A new immuno-affinity fluorimetric biosensor was recently developed for detecting and quantifying aflatoxins, a group of chemically related mycotoxins produced by common fungi (Aspergillus flavus, Aspergillus parasiticus, and Aspergillus nomius) found in maize, cottonseed, peanuts, and other nuts, grains, and spices.

The materials were filtered using sepharose bead columns that were coated with polyclonal aflatoxin specific antibodies. The bead containing bound aflatoxi was then rinsed to remove any unbound or precisely bound contaminants or interferent. Antibodies were exposed to an eluant solution during rinsing, causing the bound aflatoxi to be released. The analytes were then isolated and placed in a fluorimeter. This biosensor consisted of two major subsystems: a fluidics subsystem for handling and processing mechanical samples, and an electro-optical device with tiny fluorometers for analyzing and registering toxicity to the customer. A microprocessor connected the two systems and directed the fluidics and optical systems through the study. The aflatoxin biosensor provided a compact multi-sample, sampling, and computation capability despite restricted sample handling and consumables. It featured a wide sensitivity range of 0.1 to 50 PPB, processed 1 ml samples in less than 2 minutes, and conducted over 100 measurements without the need for refurbishment. A bio sense can identify Phytophtorainfestans-infested potatoes' marker volatiles, possibly addressing the problem of screening a large number of seeds potatoes for fungus infection. The bio sense, which is based on the Colorado potato's (Leptinotarsadecemlineata) intact antennae, was able to identify a single sick potato tuber among a batch of up to 100 kilogram tubers, suggesting that it may be utilized as an early warning system. Insect antennae are excellent candidates for the creation of highly sensitive biosensors due to their outstanding sensory capacities.

6. DISCUSSION

The researcher investigated and evaluated Biosensors for Agriculture Applications, however they did not adequately explain concepts such as biosensor definitions, agriculture definitions, biosensor application in agriculture, biosensor kinds, and so on. This paper includes information on biosensor applications in agriculture, such as a definition of biosensors, which states that a biosensor is an instrument that converts biological reactions into electrical signals, a definition of agriculture, which states that agriculture is the science, art, and practice of cultivating plants and livestock, and types of biosensors, which are divided into two parts and are recognizably different. This article also discusses biosensor applications in agriculture, such as biosensors for detecting and identifying infectious diseases in crops, which aid in the detection and identification of infectious diseases in crops, allowing us to easily protect agriculture by eliminating infectious illnesses.

7. CONCLUSION

This paper covers all aspects of mobile biosensors for agricultural applications, such as the definition of biosensors, which states that biosensor is instrument that convert biologicals reactions to electrically signal, the definition of agriculture, which states that agricultural is the art, science,and practice of yielding plant & livestock, and types of biosensors, which are divided into two sections, which include This biosensor was further subdivided into various categories. The application of biosensors in agriculture is also covered in depth in this paper. To make cells& tissuebased biosensor, genetically engineered protein are injected into cell ex vivo. The researcher were allowed to constantly and noninvasively detect levels of hormones, medicines, or poisons using bio photonics or other physical principles. In this regard, the spectrum could be considered scope in the field of aging science.

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