Journal of The Gujarat Research Society

ISSN: 0374-8588
Volume 22 Issue 1, January 2020

Study of Application of several Bio sensors in Agriculture

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ABSTRACT: Biosensors are analytical instruments that transform biological reactions into electrical signals. They include tissue-based enzyme-based, DNA biosensors, immune sensors, piezoelectric, thermal, and biosensors, among others. Biosensors may be utilised 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 critical food process parameters, measuring animal reproduction, and screening for veterinary drugs. This study investigates biosensors, their kinds, and their applications. Agriculture and the application of biosensors in agriculture are also discussed in this article. To make cell and tissue-based biosensors, genetically engineered proteins are injected into cells ex vivo or in vivo. They enable the researcher to continually and noninvasively measure levels of hormones, medicines, or poisons using bio photonics or other physical principles. In this regard, the spectrum might be useful in the field of ageing research in the future.

KEYWORDS: Agriculture, Biosensor, Enzyme, Sensor, Tissue.

1. INTRODUCTION

Biosensors are analytical devices that transform biological reactions into electrical signals. Biosensors should be extremely 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 immobilisation methods. Biosensor materials are classified into three categories based on how they work: bio catalytic, which includes enzymes, bio affinity, which includes antibodies and nucleic acids, and microbe-based, which includes microorganisms. In 1967, the first enzyme-based sensor was created. Enzyme biosensors have been developed using immobilisation methods such as Vander Waals powers covalent bonding or ionic bonding. Some of the most commonly utilised enzymes for this purpose include oxidoreductases, polyphenol oxidases, peroxidases, and amino oxidases[1].

Tissue-based sensors are made from plant and animal tissues. The analyte of interest might be a process's substrate or inhibitor. Rechnitz created the first tissue-based sensors for measuring the amino acid arginine. Organelle-based sensors were created employing membranes, mitochondria, microsomes, and chloroplasts. However, while this form of biosensor had a high level of stability, the detection time was longer and the specificity was reduced. Immuno sensor is based on the fact that antibodies have a high empathy for antigen, which means they respond perfectly to infections or metabolites, or interfere with the host's immune system. DNA (Deoxyribonucleic acid) biosensors function because single-strand nucleic acids molecules may recognise and attach to their counterpart 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 detect magnetic micro and Nano particles in microfluidic channels using the magnetoresistance effect, show a lot of potential in terms of sensitivity and scalability[2].

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As previously mentioned, a thermal biosensor, also known as a calorimetric biosensor, is constructed by integrating biosensor material with physical transducers. Two types of piezoelectric biosensors are quartz crystal micro balance and surface acoustic wave system. They rely on the computation of changes in a piezoelectric crystal's resonance frequency as a result of crystal structural changes. A light basis and a number of optically manufactured components work together to create a light beam with specified properties and guide it toward a moderating agent, a modified sensing head, and a photodetector in an optical biosensor. The discovery of green fluorescent proteins and later Auto Fluorescent Proteins variants and hereditary fusion reporters has aided the development of hereditarily encoded biosensors. Building, manipulating, and implanting this type of biosensor into cells is easy. A single-chain FRET biosensor is another example. They are made comprised of a pair of AFPs that, when placed close together, may transfer fluorescence resonance energies[3].

Different ways of controlling advances in FRET signal may be used depending on the size, ratio, or lifetime of AFPs. Peptide and protein biosensors are made via synthetic chemistry and then enzymatically tagged with synthetic fluorophores. Because they are not dependent on genetically encoded AFPs, they are simple to monitor target behaviour and make appealing alternatives. By incorporating chemical quenchers and photoactivatable classes, they may also enhance the signal to noise ratio and compassion of the reaction. Agriculture is the study, art, and discipline of raising plants and cattle. 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 species. Agriculture has a long and illustrious history that dates back thousands of years[4].

After collecting wild grains for at least 105,000 years, farmers began cultivating them around 11,500 years ago. Pigs, sheep, and cattle were domesticated about 10,000 years ago. Plants were cultivated in at least 11 distinct locations across the world. Though over 2 billion people still rely on agriculture, industrial agriculture based on large-scale monoculture came to dominate agricultural output in the twentieth century. Plant propagation, modern agronomy, agrochemicals like fertiliser and insecticides, and technical developments all raised yields substantially, inflicting havoc on the environment. Environmental problems include climate change, groundwater depletion, deterioration, antibiotic resistance, and the use of growth hormones in commercial meat processing. Agriculture is also particularly sensitive to environmental degradation, such as habitat loss, desertification, soil degradation, and global warming, all of which reduce agricultural yields. While some nations have prohibited the use of genetically modified organisms, they are routinely employed in others[5].

1.1 Principles and types of bio sensors:

The biosensor works on the principle of signal transduction. Bio recognition 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 almost every company 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 determined, or it may have a pre-existing link with the quality factor. Biosensors come in a variety of shapes and sizes, as seen below.

ISSN: 0374-8588
Volume 22 Issue 1, January 2020

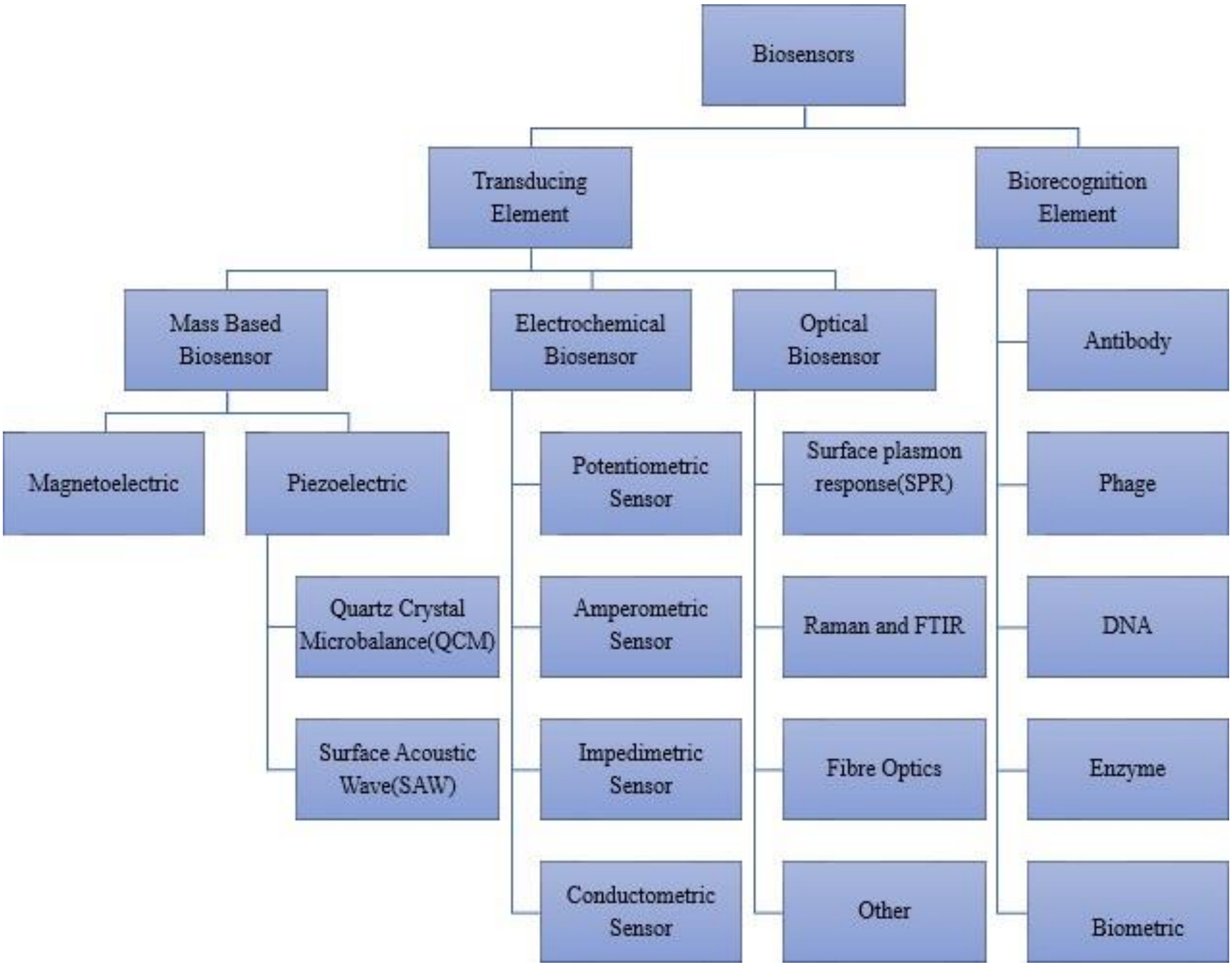


Figure 1: Representation of several types of bio sensors along with their subtypes.

Figure 1 shows the Types of Biosensor which is divided into Two Element and These Elements are Further Divided into Different Categories

1.1.1 Electrochemical Biosensors:

An electrochemical biosensor is a type of sensor that converts biological events into electrical impulses. In that type of sensor, the electrode is a critical component, providing as a robust support for biomolecule hold and electron flow. Thanks to different nanomaterials with large surface areas, synergic effects are aided by improved loading capability as well as mass transportation of reactant 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 follow. The produced signal can be converted into one of

ISSN: 0374-8588
Volume 22 Issue 1, January 2020

two types of signals[6]. Biosensors that are potentiometric and biosensors that are amperometric are two types of biosensors.

1.1.2 Potentiometric Biosensors:

This is dependent on detecting the potential of a system's working electrodes in respect to precise reference electrodes in the absence of current flow. In the method, potentiometric measurements in the test sample are connected to analyte behaviour. A potentiometric biosensor can detect a wide range of concentrations (sometimes many orders of magnitude). Potentiometric biosensors haven't seen as much usage in food safety testing as amperometric sensors. Only a few instances of how this approach has been utilised for food quality studies include determining monophenolase activities in apples juice, estimating sucrose concentrations in soft drinks, evaluating isocitrate concentrations in fruit juices, and determining urea levels in milk.

1.1.3 Amperometric Biosensors:

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 (oxidising) reactions may be followed perimetrically[7]. 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.

1.1.4 Calorimetric Biosensors:

In both chemical and biological processes, heat is transferred. As a result, calorimetric-based biosensing devices have benefited from the basic notion of heat production and absorption originating from all biological processes [7]. Heat absorptions or processing are involved in the majority of biological processes. Sensors based on calorimetric transduction are meant to detect heat created or consumed during a biological reaction by using responsive heat detection equipment. Biosensors have been created for a range of target analytes. This biosensor's use for detecting metabolites has been discovered in the field of food quality analysis.

1.1.5 Optical Biosensors:

These sensors evaluate how people react to illumination or light pollution. Some of the techniques 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 polarisation, and total internal reflectance. This method is used, for example, to identify the presence of allergens, particularly peanuts, during the production of food.

1.1.6 Acoustic Biosensors:

In acoustic wave biosensors, acoustic or mechanical waves are utilised as a sensing instrument to collect medical, biochemical, and biophysical information about the analyte of interest [8]. It detects changes in mass, elasticity, conductivity, and dielectric characteristics caused by

ISSN: 0374-8588
Volume 22 Issue 1, January 2020

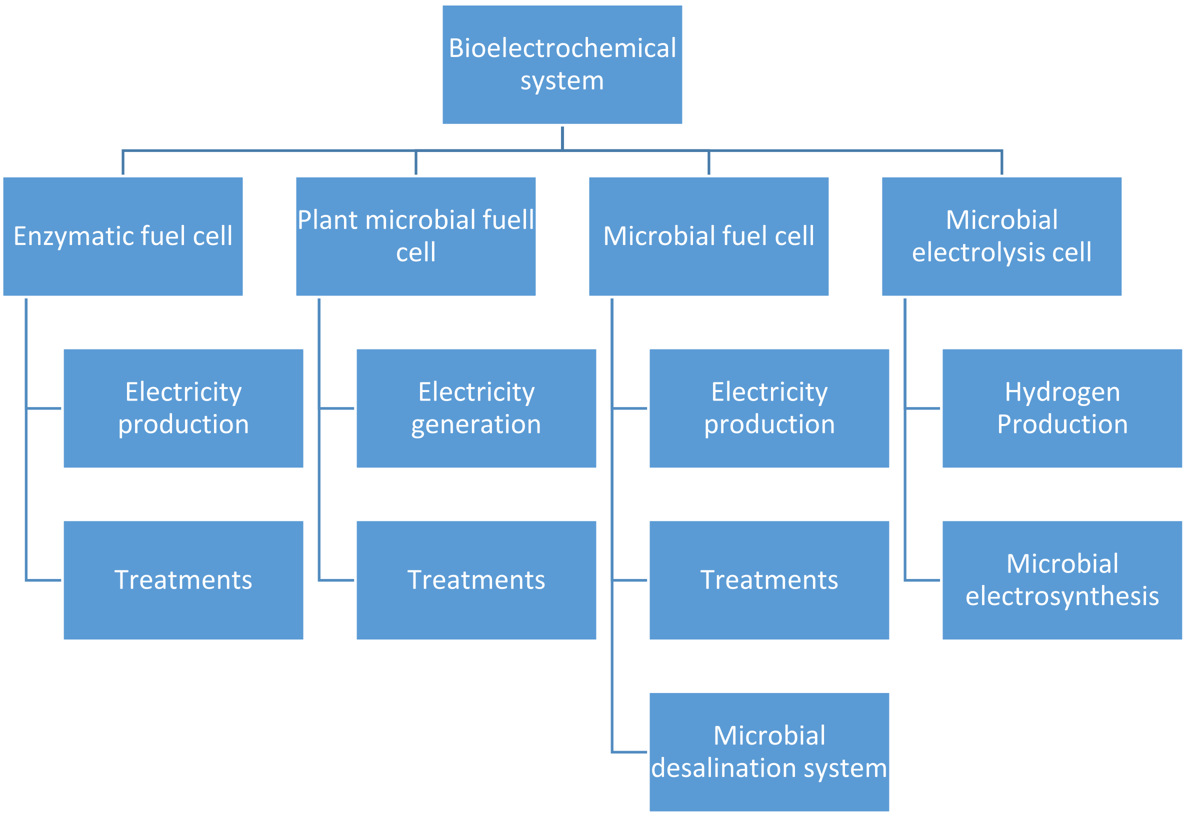
mechanical or electrical forces. Changes in mass at crystal surfaces can affect piezoelectric quartz crystals; this phenomenon has been successfully explored and applied to the development of acoustic biosensors. For functional applications, the surfaces of crystals can be altered with identifying components that bind directly to the target analyte.

1.1.7 Immuno-Sensors:

Immunosensors are solid-state devices that bind to a transducer via an immunochemical reaction. 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 commonly used in immunoassays to monitor the immunological response. The combination of a biosensor platform with an immunoassay format enables for quick and exact quantitative measurements of the target analyte.

1.2 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 generally consists 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. Figure 2 displays optical (chemiluminescence, fluorescence, and surface plasmon resonances calorimetric) and electrical (voltammetry, capacitance, and impedance) signals, as well as any other format specified. Sensor categorization is discussed in greater depth elsewhere.



ISSN: 0374-8588
Volume 22 Issue 1, January 2020

Figure 2: Representation of Sensor categorization of bio electrochemical system.

Figure 2 shows the Bio electrochemical System which is Further Divided into Four Cell and these Cells are Further Divided into Different Categories.

2. LITERATURE REVIEW

Suresh Neethirajan et.al discussed how the rising human population, the maintenance of clean water and food quality, and the conservation of the climate and environment all offer substantial difficulties to current food production. Food security is mostly a joint effort combining both public and private sector technological progress. Several attempts have been made to solve issues and enhance food processing drivers. Biosensors and biosensing instruments, as well as their implementations, are frequently utilised to address some of the most critical food processing and sustainability concerns. As a result, the need for biosensing technologies in the food industry is growing. Microfluidics is a type of technology that integrates many technologies. Nanomaterials, with their biosensing technology, are seen to be the most promising technique 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 engineering, and quality assurance. The current state of development knowledge, solutions, and prospective issues, as well as biosensor commercialization, are summarized[8].

Parikha Mehrotra discussed many types of biosensors, such as tissue-based, enzyme-based immunosensors, Deoxyribonucleic acid biosensors, piezoelectric, and thermal biosensors, 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 saccharification 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 require fluorescent biosensors. Biosensor applications are frequently utilised in plant biology to discover missing links in metabolic processes. Other uses include defence, the therapeutic market, and marine applications[9].

Maria N. Velasco-Garcia and colleagues conducted research in which they discussed how Biosensor technology is a strong alternative to standard analytical procedures 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[10].

3. DISCUSSION

ISSN: 0374-8588
Volume 22 Issue 1, January 2020

Researchers have investigated and analysed Biosensors for Agriculture Applications, but they did not adequately explain concepts such as biosensor definitions, agriculture definitions, biosensor application in agriculture, biosensor types, 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 practise of cultivating plants and livestock, and types of biosensors, which are divided into two parts and are recognisably different. Furthermore, this biosensor is divided into various categories, as well as bio sensing technology in food susceptibility. This paper 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 prevent agriculture by removing infectious diseases.

4. CONCLUSION

This paper covers all aspects of mobile biosensors for agricultural applications, such as the definition of biosensors, which states that a biosensor is an instrument that converts biological reactions into electrical signals, the definition of agriculture, which states that agriculture is the science, art, and practise of cultivating plants and livestock, and the types of biosensors, which are divided into two sections, which include The application of biosensors in agriculture is also covered in depth in this study. To make cell and tissue-based biosensors, genetically engineered proteins are injected into cells ex vivo or in vivo. They enable the researcher to continually and noninvasively measure levels of hormones, medicines, or poisons using bio photonics or other physical principles.

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