APPLICATIONS OF BIOSENSORS IN AGRICULTURE

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Abstract

The biosensor is analytical instrument that convert biological reaction into an electrical signal there are different types of biosensors, such as tissue-based enzyme-based, , DNA biosensors immunosensors, piezoelectric, thermal, and biosensors. Biosensors can be used in a variety of agricultural applications, including analyzing toxins in soils, and crops detecting and identifying infectious disease in crop and animals, on line measurement of vital food process criteria, measuring animals reproduction, and screen rupeutic drug in veterinaries research. This paper studies about the biosensor, types of biosensor etc. this paper also focuses on agriculture and usage of biosensor in agriculture etc. Genetically modified proteins are injected into cells ex vivo or in vivo to create cell and tissue-based biosensors. Using bio photonics or other physical concepts, they enable the researcher too continuously and noninvasively sense levels of hormones, medications, or toxins. In this respect, the spectrum could be use in future in ageing science.

Key words: Agriculture, Biosensor, Enzyme, Sensor, Tissue.

Introduction

Biosensors are the analytical instruments which convert biological reaction into an electrical signals[1]. Biosensor should be highly exact, reusable, and not dependent of physical parameter such as pH and temperatures. The biosensors, their architectures, transducing mechanisms, and immobilization method include multidisciplinary study in engineering, chemistry and biology. Biosensor material are divided into 3 classes depending on their mechanism: biocatalytic, which includes enzymes, bio affinity, which includes antibodies and nucleic acids, and microbe-based, which includes microorganism. The first enzyme-based sensor developed in 1967. Immobilization techniques, such as Vander Waals powers covalent bonding, or, ionic bonding have been use to develop enzyme biosensors. Oxidoreductases, polyphenol oxidases, peroxidases, and amino oxidases are some of the most widely used enzymes for this function.

Plant and animal tissues are used to make tissue-based sensors. The analyte of interest may be either a substrate or an inhibitor of processes. The 1st tissue based sensors for determinations of the amino acids arginine was invented by Rechnitz. Membranes, mitochondria, microsomes, and chloroplasts were using to creates organelle-base sensors. However, stability of this types of biosensors were high, but detections time was longer and specificity was lower. Immunosensor is based on fact antibodies have a high empathy for antigen, means they exactly react to pathogens or metabolites, or interfere by means of immune system component in host. Single strand nucleic acids molecules can identify and binds to their complementary strand in a sample, which is how DNA (Deoxyribonucleic acid) biosensors work. The association between two nucleic acid strands is due to existence of stable hydrogens bond between them. Magnetic biosensors are miniaturized biosensors that use the magnetoresistance effect to track magnetic micro and nano particle in microfluidic channel have lot of promise in term of sensitivity and scale.

Thermal biosensor, also known as calorimetric biosensor created from incorporating biosensor material into physical transducers, as previously described. Quartz crystal micro balance as well as surface acoustic wave system is two kinds of piezoelectric biosensors. They are dependent on the calculation of variations in a piezoelectric crystal's resonance frequency as a result of form change in crystal structures. Optical biosensor is made up of light basis and a numbers of optically make component that work together to produce light beam along specifics characteristics and directs it toward a moderating agent, a altered sensing head, and a photodetector. The developments of hereditarily encode biosensors has been supported by the development of green fluorescents proteins and subsequent Auto Fluorescent Proteins variant and hereditary fusion reporters

This form of biosensor is simple to build, manipulate, and implant into cells. Another representation is a single-chain FRET biosensor. They are made up of a pair of AFPs that can transmit fluorescence resonances energies when brought close together.

Depending on the size, ratio, or lifespan of AFPs, different approaches might be uses to control improvements in FRET signal. Synthetic chemistry is used to make peptide and protein biosensors, which are then enzymatically labeled with synthetic fluorophores. They are easily used to monitor target behavior and represent enticing substitutes because they are independent of genetically-encoded AFPs. They also have the added benefit for able to improve signal to noise ratio and compassion of reaction by introducing chemical quenchers and photoactivatable classes[2].Plant and livestock cultivation is the study, craft, and discipline of agriculture. Agriculture was a crucial development in the growth of sedentary human civilization, as it enabled people to live in cities by creating food surpluses from domesticated species. Agriculture has a long tradition dating back thousands of years.

Farmers started planting wild grains about 11,500 years ago, after harvesting them for at least 105,000 years. Domestication of pigs, sheep, and cattle began over 10,000 years ago. Plants were grown separately in at least 11 different parts of the planet. In the twentieth century, industrial agriculture based on large-scale monoculture came to dominate agricultural production, though around 2 billion people still relied on agriculture. plant propagation, Modern agronomy, agrochemical like fertilizer, pesticides, and technological advancements dramatically increased yields thus wreaking havoc on the environment. Contributions of climate warming, aquifer depletion, degradation, antibiotic resistance, and growth hormones in commercial meat processing are also environmental concerns. Agriculture is also particularly vulnerable to environmental destruction, such as habitat depletion, desertification, soil degradation, and global warming, both of which result in lower crop yields. While certain genetically modified species are banned in some countries, they are widely used[3].

Principle and types of biosensor:

Biosensor operated base on principle of signals transduction. These component include biorecognition elements and electronic systems composed of display, amplifier and processor. Since nearly every industry and government service depends on quality management, investigative chemistry play important roles in food quality parameter. A food quality biosensor is a system that can sense and convert any or more of the properties of food into visible signals, usually electric signals This signals could have precise knowledge about quality factors to calculated, or it could have an established relationship with the quality factor. There are various kinds of biosensors as shown in Figure1 are given below[4]:

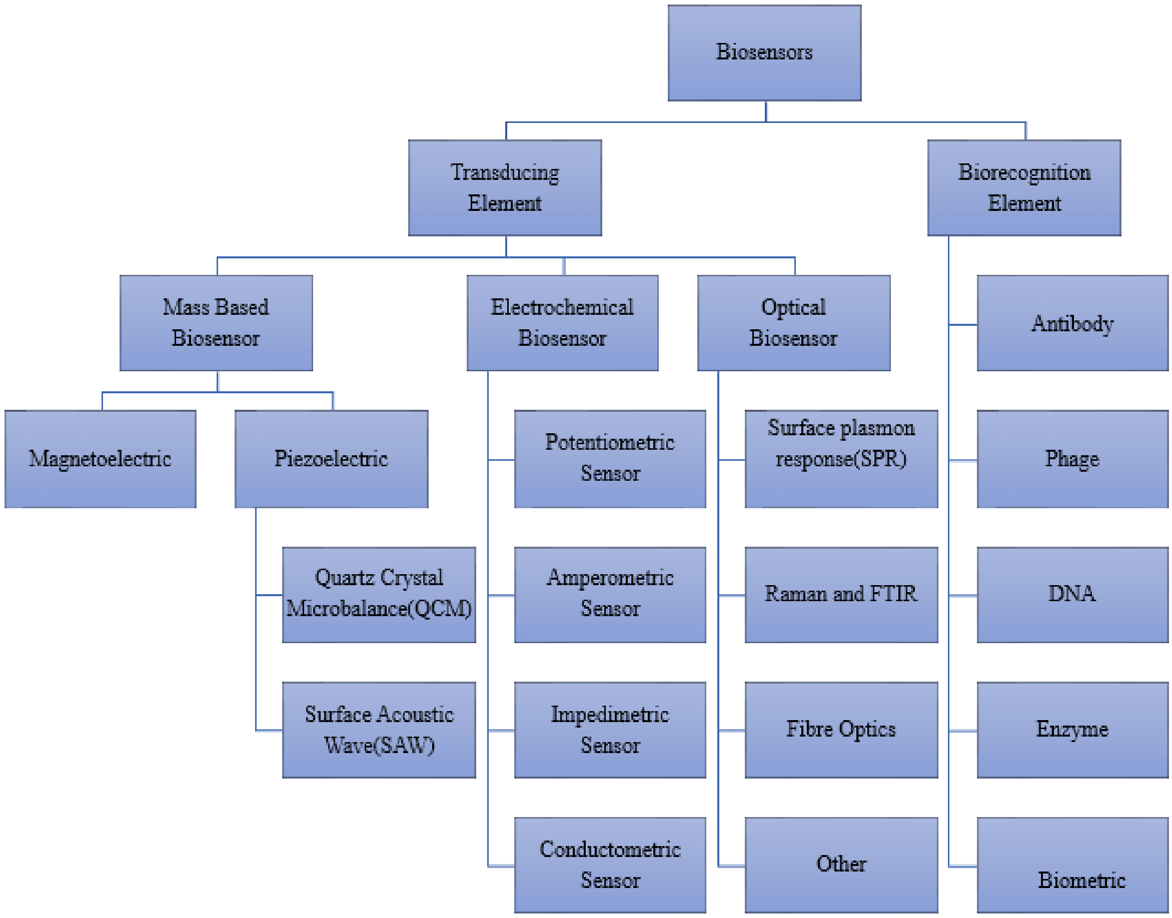

Figure 1: Shows the Types of Biosensor which is divided into Two Element and These Elements are Further Divided into Different Categories.

1) Electrochemical Biosensors:

The electrochemical biosensor is common sensing system that works by converting biochemical events into electrical signals. Electrode is crucial components in that form of sensors, serving as strong supports for biomolecule hold and electrons movement. Synergic effect are facilitated by improve loading capability as well as mass transports of reactant for achieve large efficiency in terms of analytical sensitivity, thanks to various nanomaterials with wide surface areas[5]. Electrochemical biosensors are biosensors that use an electrochemical transducer to operate. They can track both biological and nonbiological products, such as hormones, whole cells, complex ligands, and tissues. The generated signal may be transduced use one of various methods that fall into two categories: Biosensor that are potentiometric and biosensor that is amperometric[6] .

2) Potentiometric Biosensors:

This are dependent on measuring a system's potential at working electrodes in relation to accurate references electrodes under virtually no current flow. Potentiometric measures in the test sample are linked to analyte behavior in procedure. Potentiometric biosensor can detect a extensive range of concentrations (typically many order of magnitudes). Potentiometric biosensors have not been used for food safety analysis as extensively as amperometric sensors. Finding monophenolase activities in apples juice, calculating concentrations of sucrose inside soft drinks, testing isocitrate concentrations in fruit juices, and finding urea level in the milk are only a few examples of how this technique has been used for food quality research.

3) Amperometric Biosensors:

Amperometric biosensors have proven to be the most commonly published electrochemical method in signal transduction. Commercially available “one shot” sensors and on line) instruments track a broad variety of target analytes. The theory function of amperometric biosensor is characterized by constant potential applied between working and a reference electrode, unlike amperometric instruments. Redox reactions occur as a function of the added potential, allowing a net current to circulate. Both cathode (reducing) and anode (oxidizing) reaction can tracked perimetrically, and the amplitude of this current is proportional to concentrations of electro actives species presents in the test solutions. The biorecognition factor in the majority of the amperometric biosensors mentioned is enzymes. Typically, the most common used catalysts for these biosensor formats have been oxidase and dehydrogenase enzymes.

4) Calorimetric Biosensors:

Heat is exchanged in both chemical and biological reactions. As a result, the basic concept of heat generation and absorption arising from all biochemical reactions has aided the development of calorimetric-based biosensing devices [7]. The majority of biochemical reactions involve either heat absorptions or processing. By employing responsive heat detections instruments, sensor based on calorimetric transduction are designed to detect heat produced or ingested during a biological reaction. Biosensors for a variety of target analytes have been developed. The uses of this biosensor for detects metabolites has been identified in field of food qualities analysis.

5) Optical Biosensors:

The reactions to lighting or light pollution are measured by these sensors. fluorescence, Chemiluminescence, , phosphorescence, photo thermals processes light absorbance, surfaces plasmon resonances (SPR), lights rotation and polarization, and overall internal reflectance are some of the techniques used in optical biosensors to detect the presence of a target analyte. This technique, example use for detect presence of allergens, especially peanut, during food preparation.

6) Acoustic Biosensors:

Acoustic or mechanical waves are used as a sensing tool in acoustic wave biosensors to collect medical, biochemical, and biophysical knowledge about the analyte of interest [8]. It sense mechanical or electrical differences in mass, elasticity, conductivity, and dielectric properties. A changes in masses at crystal surfaces can impact piezoelectric quartz crystals; this effect has positively exploited as well as use to create acoustic biosensor. The surfaces of crystal can changed with identification elements that bind directly to target analyte for functional applications.

7) Immunosensors:

Immunosensors are solid-state devices that use an immunochemical reaction to bind to a transducer. They are one of the most important forms of affinity biosensors because, like immunoassays, they depend on antibodies to identify antigens and form a stable complex. Immunosensors work by taking advantage of the unique interactions between antibodies and antigens. To monitor the immunological reaction, immunoassays usually use a labels .Use of biosensors platform in conjunction with an immunoassay formats allows for fast and precise quantitative measurements of the target analyte.

Biosensing Technologies And Food Sustainability:

Biosensor is analytical instrument that measures the concentration of a molecules of interests (targets) in sample. It usually consists of a biorecognition factor (antibody, enzyme, and aptamer so on) that is unique to the target. Physiochemical or biological signals is elicited by molecules recognitions event between the recognitions factor and target compounds, which is translated into an observable quantity by the transducer. Optical (, chemiluminescence, fluorescence, and surface plasmons resonances calorimetric) or electricals (voltammetry, capacitance and impedance) signals are shown in Figure 2, as well as some other chosen format. Sensor classification is covered in detail elsewhere[4].

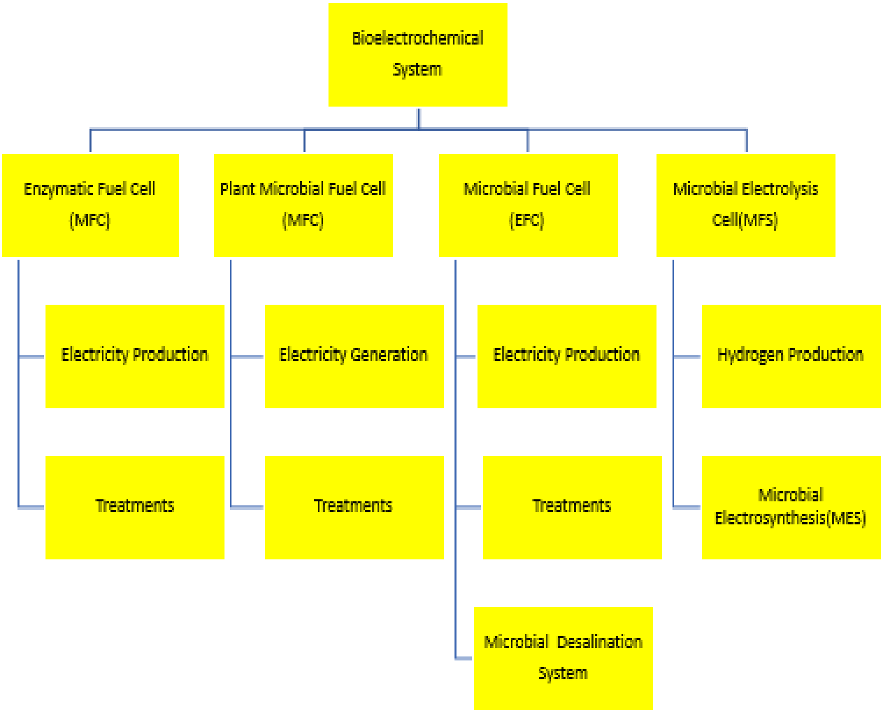

Figure 2: Shows the Bio electrochemical System which is Further Divided into Four Cell and these Cells are Further Divided into Different Categories.

In the field of food sustainability, there is an increasing need for biosensing technologies, which address all five of the above challenges. New energy sources are one of the obstacles, as current dependence on fossil fuels has reduced their supply, potentially resulting in emissions. Bio electrochemical system(BES) are developing in exploration of renewable power supplies, chemicals processing, resources recycling as well as waste remediations to address the energy problem. These one-of-a-kind systems use microbe as catalyst extracted from organics wastes like lignocellulosic biomasses and low strength wastewater to transform chemical energy to electrical energy in both directions .The devices can be built to generate electrical energies that can be used to make hydrogen, peroxide, and caustic, as well as to recycle metals and nutrients and eliminate recalcitrant compounds.

For novel separators, electrodes, and catalysts, new concept and groundbreaking design have applied for these devices. Cause of rapid urbanization deforestation,, industrialization, global land depletion and inefficient land use, is one of most serious problems in food productions. Land loss has grown to 12.2 billion hectares worldwide in the last few decades, affect 1.6 billion people. Bioremediation, on other hand, as promising technique for restoring degrade and contaminated soil, have some possible field limitation. New biotechnology advances, like using enzyme with high precisions, producing microbials consortia, as well as using plant with microbials s collaborators, are encouragingly leading to new directions in sustainable land regeneration. The key issues are that land regeneration efforts must linked to additionally advantages, like agricultural bioproducts, soil carbon sequestration, biomass materials and biofuel, and that restorations activities must contaminant and site specific to suit the social conditions and soil relevant areas. Biosensors with electrochemical impedance spectroscopy, which use a small amplitude Alternating current voltage in the sensing electrodes to calculate current response as frequency, have been commonly used in sustainable food processing.

Impedance biosensors have the ability to be built into compact sensor for environmental monitor and study due to their all-electrical design. For e.g. an impedance biosensors have designed for detect BDE-47 and norfluoxetine, two endocrine disrupting chemicals with detection limits of 1.4 and 8.4 ng/mL, respectively. While impedance biosensor have been extensively studied in academic studies, their commercialization has been hampered through a number of factor, including the difficulty of impedance detection, biomolecule immobilization stability, smaller analytes, and nonspecific absorption susceptibility. Figure 2 shows a diagram of different types of bio-electrochemical structures (BESs). Due to increased urbanization, industrialization, erosion, and unsustainable land use, global land depletion is one of the most pressing issues in food supply. Global soil loss has risen to 12.2 billion hectares in the last two decades, affecting 1.5 billion people. Bioremediation, on the other hand, as a practical tool for restoring degraded and contaminated soil, has several possible field flaws. New biotechnology advances, such as high-precision enzyme usage, microbial consortia production, and the use of plants with microbial partners, are leading to new directions for sustainable land regeneration. The key issues are that land regeneration efforts must correlated to extra advantages, like agricultural bioproducts, biofuel and wood materials, and soil carbon sequestration norfluoxetine, with identification limit of 1.4and 8.6 ng/mL, respectively. While impedance biosensors have been extensively study in academics studies, commercialization have hampered by number of factors, including the difficulty of impedance detections, biomolecule immobilization stability, smaller analytes, and nonspecific absorption vulnerability.

Biosensor For Finding And Identfication Of Infectious Diseases In Crops In Agricalture

Pathogens are microorganisms that invade crops and cause illness, often in epidemic quantities. They include bacteria and fungi. Aflatoxin production and fungus infection may occurs at stages of harvesting, plant growth, drying, storage, and refining. Aflatoxin exposure by ingestion or inhalation can result in the creation of severe medical conditions (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 food items are closely monitored and controlled by US government agencies. Usually, action standards of 20 ppb are used to extract human food items from the market. A new immuno-affinity fluorimetric biosensor for detecting and quantifying aflatoxins, a group of chemically related mycotoxins generated by common fungi (Aspergillus flavus, Aspergillus parasiticus, and Aspergillus nomius) found in maize, cottonseed, peanuts, and other nuts, grains, and spices, was recently created.

The samples was filter into a columns of sepharose bead, which were coated with polyclonals aflatoxin specific antibody.. Following that, the bead with bound aflatoxi were rinse to clear any unbounded or precisely bound impurities or interferent. Rinsing, antibodies were exposed to an eluant solution, which caused the bound aflatoxi to be released. After that, the analytes was extracted and put in fluorimeter. This biosensor had two main subsystem: a fluidics subsystem that handled and processed mechanical samples, and an electro-optical device with a mini fluorometers which analyzed and registered toxin to consumer. The two systems were linked by a microprocessor that guided the fluidics and optical systems through the research. With limited sample handling and consumables, the aflatoxin biosensor supported a compact multi-sample, sampling, and calculation functionality. It had large sensitivity from 0,1 to 50 PPB, took fewer than 2 minute to process a 1 ml samples, and performed over 100 measurement with no need for refurbishment (Carlson et al., 2000). A bio sense can detect marker volatiles produced by Phytophtora infestans-infested potatoes, potentially solving the issue of screenings large number of seeds potatoes for fungal infestation. The bio sense, which is dependent on the intact antennae of the Colorado potato (Leptinotarsa decemlineata),able for detect a single disease potato tuber inside a batch of up to 100 kg tubers, indicating that it could be used as an early warning system. Because of their exceptional sensory abilities, insect antennae are ideal candidates for the development of extremely responsive biosensors.

Literature Review

Suresh Neethirajan et.al studies the growing human population, the preservation of clean water and food quality, and the protection of the atmosphere and environment all pose significant challenges to existing food production. Food security is largely a collaborative endeavor involving both government and private sector technology advancement. Several efforts have been made to address problems and improve drivers in food processing. Biosensors and biosensing tools, as well as their implementations, are being commonly used to address some of the most pressing issues in food processing and sustainability. As a result, there is an increasing need for biosensing technology in the field of food sustainability. Microfluidics is a technological device that combines many technologies. Nanomaterials, with its biosensing technology, are considered to be the most exciting method for addressing health, energy, and environmental problems that affect global populations. The demands to Point-of-Care (POC) technology in field is for analytical instruments that are fast, convenient, reliable, compact, and low-cost. Biosensing for food manufacturing, food distribution, safety and protection, food package and supply chains, food wastage processing, food food engineering and quality assurance, are all discussed in this study. The existing state of knowledge about development, solutions, and potential problems, as well as biosensor commercialization, are summarized[9].

Maria N. Velasco-Garcia et.al studies Biosensor technology, which harnesses the sensitivity and specificity of biological system in lightweight, low cost sensors, is a powerful alternative to traditional analytical techniques. Despites promising biosensor built in investigation labs, there're few records of agricultural monitor applications. The author explore biosensors technologies and various bio receptor mechanisms as well as transduction processes. Differences between biosensor and fully integrate biosensor systems are described, as well as the key reasons for biosensor technology transition being sluggish. The primary focus of development biosensor research has on environmental technologies, health care and the food industry. Diabetics' hand-held glucose meters are the most commercially relevant application. There have been a variety of diagnostic tests in the agricultural/veterinary research industry, but not true biosensor system have complete an impacts. Biosensor 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 parameter, tracking animal fertilities, and screening therapeutic drugs in veterinary test due to the essential for quick, accurate sensing correct sensing and on-line . Future issues in biosensor commercialization are also discussed[10].

J.S Rana et.al studies Food content is largely determined by the biochemical structure of the food. As a result, this study summarizes recent advancements in the manufacturing of various types of Biosensors for the calculation of various components in horticultural samples. They look at electrochemical, calorimetric, optical, and immunosensors, as well as screen-printed three-electrode devices. Several primary examples are given, including glucose, fructose, malic acid, pyruvic acid, ascorbic acid, glycerol, glutamate, and others[4].

Parikha Mehrotra Biosensors of different forms, like tissue-based, enzyme-based immunosensors, Deoxyribonucleic acid biosensors, , piezoelectric and thermal biosensors, have discussed to illustrate critical application in a variety of field. The food industry uses biosensors to track consistency and protection, as well as to differentiate between artificial and natural ingredients; fermentation manufacturing uses biosensors in saccharification procedure to detects specific; metabolic engineering and glucose concentration uses biosensors to allow in-vivo monitoring of cellular metabolisms. Biosensors ,their use medical research, such as early detections of human interleukin 10, which causes heart disease, and quick detection of the human papillomavirus, are significant things to consider. Fluorescent biosensors are essential in drug development and cancer research. In the field of plant biology, biosensor applications are often used to identify missing connections in metabolic processes. Defence, the clinical market, and maritime applications are among the other applications[2].

Discussion

The researcher studies and analyzed about the Biosensors for Applications in Agriculture but they didn't explain well like the definition of biosensors, definition of agricultures, application of biosensor for application in agriculture, biosensor types etc. This paper gives all details about Biosensor applications in Agriculture like definition of Biosensors which states that a biosensor is instrument which convert biological reaction into electrical signals, definition of Agriculture which states that agriculture is the science, art and practice of cultivating plants and livestock, types of bio sensor which is divided into two parts which is recognition and transducing element which is further divided into different attacks like mass based ,optical ,electrochemical biosensor etc. aa well as this biosensor further divided into different categories and bio sensing technology in food susceptibility. This paper also provide application biosensors in agriculture in for example biosensor for detections and identifications of infectious diseases in crop in agriculture which help for the detection and identification in crops by this we can prevent agriculture easily by removing infectious diseases

Conclusion

This paper gives all details of mobile Biosensors for Applications in Agriculture like definition of Biosensors which states that biosensor is instrument which convert biological reaction to electrical signals, the definition of Agriculture which states that agriculture is the science, art and practice of cultivating plants and livestock, types of bio sensors which is divided into two parts which is recognition and transducing element which is further divide into many attacks like mass based ,optical ,electro-chemical biosensor etc. this biosensor further divided into different categories. This paper also provide application of biosensors in agriculture in detail. Genetically modified proteins are injected into cells ex vivo or in vivo to create cell and tissue-based biosensors. Using bio photonics or other physical concepts, they enable the researcher too continuously and noninvasively sense levels of hormones, medications, or toxins. In this respect, the spectrum could be scope in ageing science**.**

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