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Biosensor for Detection of Pesticide Residues in Fruits and Vegetables

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SUMMARY

Biosensor is as a compact analytical device incorporating a biological or biologically derived sensing element either integrated within or intimately associated with a physicochemical transducer. It incorporates a biological sensing element either intimately connected to or integrated within a transducer. Recognition based on affinity between complementary structures like enzyme-substrate, antibody-antigen, and receptor-hormone complex. Selectivity and specificity of the biosensor depends on the biological recognition systems connected to a suitable transducer.

INTRODUCTION

India is the second-largest producer of horticulture, producing about 12% of the global fruit and vegetable production. The horticulture production for 2020-21 was estimated to be 329.86 million metric tonnes. Where fruits accounted for 103.03 MMT and vegetables 197.23 MMT. Andhra Pradesh, Maharashtra, Uttar Pradesh, Madhya Pradesh, Gujarat, Karnataka and Tamil Nadu are the major Fruits producing States, whereas Uttar Pradesh, West Bengal, Madhya Pradesh, Bihar, Gujarat, Maharashtra and Odisha are the major Vegetables producing states of the country. Tamil Nadu has production of 5767950 MT of fruits and 6082540 MT of vegetables. (National Horticulture Board, 2021). According to department of horticulture and plantation crops Government of Tamil Nadu, State leads in banana production with 32,05,035 MT followed by Mango (1268017 MT) and watermelon (216316 MT). Tapioca, Onion, Tomato, Brinjal, Moringa & okra are the main vegetables grown in the state.

Due to the increasing demand of fruits and vegetables and with the aim of achieving high productivity, pest control is managed using a wide variety of intentionally toxic compounds, pesticides which are released into the environment with serious consequences (Bogdan et al., 2018). The organophosphorus pesticides (OP) such as malathion, paraoxon, parathion, diazinon, and dichlorvos are the most extensively used in modern agriculture due to their low cost and their high effectiveness against the insects on rice, cotton, and vegetables (Saeed et al., 2020). the analysis and monitoring of the pesticides residue in the food and water must be continuously carried out on-situ and in real time to ensure food quality and to protect the human from possible dangerous hazards.

Principle of biosensor

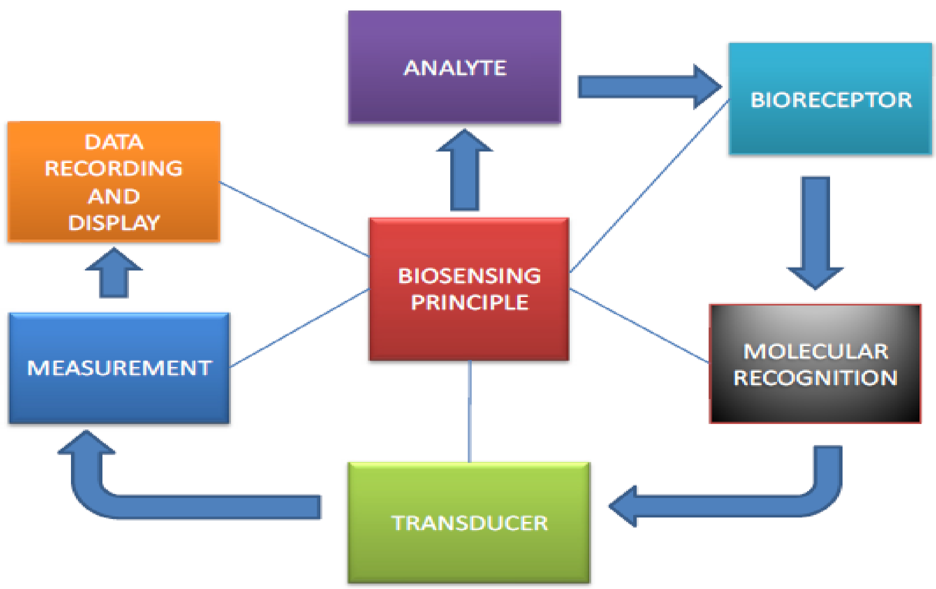

Figure 1. Basic principle of biosensor

The basic principle of biosensor (fig.1) involved in three elements:

- A Biological Recognition System, Often Called A Bioreceptor,
- A Transducer
- Microelectronics.

The main purpose of the recognition system is to provide the sensor with a high degree of selectivity for the analyte to be measured. The interaction of the analyte with the bioreceptor is designed to produce an effect measured by the transducer, which converts the information into a measurable effect such as an electrical/ optical signal.The biological element or bio element interacts with the analyte being tested and the biological response is converted into an electrical signal by the transducer.

Pesticide detection using biosensor

Bogdan et al., (2018) stated that various types of biorecognition elements can be used in biosensors to achieve specific and sensitive recognition of target pesticide in complex mixtures: whole cells or subcellular fragments of microorganisms, enzymes, antibodies, DNA sequences, aptamers, or enzymes. However, there is a research gap in optimizing the electrode immobilization conditions and development of methodology for the detection of pesticides present in fruits and vegetables. Vicky et al., (2007) achieved monitoring of the organophosphorus pesticides dichlorvos and paraoxon at very low levels with liposome-based nanobiosensors. The enzyme acetylcholinesterasewas effectively stabilized within the internal nano-environment of the liposomes. They as found that the decrease of the liposome biosensors signal is relative to the concentration of dichlorvos and paraoxon down to 10−10M levels. Yingying et al., (2015) for the electrochemical detection of carbaryl and monocrotophos modified the electrode for adsorbing AChE on the biocompatible matrix. Under optimum conditions, the developed biosensor detected carbaryl and monocrotophos ranging from 1.0×10^{-14} to 1.0×10^{-8} M and from 1.0×10^{-13} to 5.0×10^{-8} M. The detection limits for carbaryl and monocrotophos were 5.3×10^{-15} M and 4.6×10^{-14} M, respectively.

CONCLUSION

Biosensors such as electrochemical biosensors are being developed for the detection of pesticide residues, which are comparatively more convenient and sophisticated than traditional methods and can achieve field tests with rapid, specific, and highly sensitive detection. Additional advantages include their compatibility with microfabrication technology and their cost-effectiveness compared to conventional methods of detection.

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