Effective of Detection of Insect Infestation in Fruits: Survey

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ABSTRACT - Using a variety of non-destructive technologies, food scientists have attempted to develop new technologies that can improve the detection of insect infestation in fruits and vegetables under postharvest conditions over the last two decades. While consumers' expectations for higher nutritive and sensory value in fresh produce have grown over time, they have also become more sceptical of the use of insecticides or synthetic chemicals to protect food quality from insect attacks or to improve the quality attributes of minimally processed fresh produce. Furthermore, regulatory agencies' increasingly stringent quarantine measures for commercial import–export of fresh produce necessitate the development of more reliable technologies for detecting insect infestation in fruits and vegetables prior to commercialization. For these reasons, the food industry is looking into non-destructive ways to improve food quality. Several studies have been conducted to develop rapid, accurate, and dependable insect infestation monitoring systems to replace invasive and subjective methods that are frequently ineffective. There are still significant limitations to effective in-field and postharvest on-line monitoring applications. This review provides an overview of current non-destructive techniques for detecting insect damage in fruits and vegetables, as well as basic principles and applications.

Keywords: non-destructive detection, noninvasive technology, infestation

I. INTRODUCTION

Fruit and vegetable consumption has increased significantly in recent years, which can be attributed to a variety of factors, including increased awareness of their health benefits [1]. Consumers, particularly “Generation Z,” which accounts for approximately 32% of the US population, are more aware of what they eat, and many of them prefer to eat healthy, often preferring organic foods [2]. The ease of access to information via smart devices has also increased consumer understanding of what they eat, and many more people, beyond the younger generations, are gravitating toward more natural, minimally processed, and organic food. This demand is driving the trend toward affordable high-quality, consistent, and safe products [3]. The agricultural production sector, food industry, and regulatory agencies are all tasked with meeting the growing demand for low-toxicity pesticide-free produce. To meet quality and demand efficiently, destructive and o -line conventional quality assessment methods must be replaced with rapid, non-invasive, environmentally friendly, and accurate methods for quality assessment and safety assurance [4].

Governments are enacting increasingly stringent quarantine measures in order to prevent economic and ecological losses caused by alien insect pests. For example, the US government's Fruits and Vegetables Import Requirements (FAVIR) mandate preclearance of horticultural consignments in exporting countries, as well as inspections at ports of entry for any live larva or pupa of quarantine pests. In general, phytosanitary physical inspections against any quarantine-significant insect in fruits and vegetables are conducted using a biometrically designed statistical sampling [11].

According to a 2017 United States Department of Agriculture (USDA) report on US plant inspection stations, plant materials are mostly inspected physically, with some modern technologies like digital imaging, X-ray, and molecular detection tools for low-volume plants, plant cuttings, and seeds. As a result, non-invasive detection methods that are automatic, fast, and reliable are required to monitor quarantine pest presence and internal quality of fruits and vegetables in high-volume shipments [12].

II. TRADITIONAL APPROACHES

Insect identification methods in horticultural products have traditionally been manual and destructive, relying on external morphology such as defects, colour, and size, protein analysis such as enzyme electrophoretic discrimination, and molecular tools such as deoxyribonucleic acid (DNA) analysis. As a result, most traditional methods for assessing the quality of fruits and vegetables are time-consuming, labor-intensive, tedious, costly, and subjective [30]. Manual and destructive methods of quality evaluation, on the other hand, are unsuitable for industries such as packaging because they rupture the fruit tissue and make it impossible to evaluate a complete sample. For example, internal defects are detected directly by manual destructive sampling and searching for defects, or indirectly by correlating the results obtained from assessing other chemical or physical characteristics, such as ripening measurement based on colour or firmness.

Because they are based on physical properties that correlate well with certain quality factors of fruits and vegetables, non-destructive methods are more effective than traditional conventional methods. Furthermore, non-destructive methods are superior to traditional destructive methods because they do not rupture the fruit tissue and can be used to evaluate the internal structures and quality of fruits and vegetables. It is useful in sorting superior quality fruits and vegetables from substandard ones in the online system based on their size and shape, and sampling of all fruits and vegetables is performed to ensure maximum quality.

III. NONINVASIVE METHODS

Spectroscopy methods provide operational information about the chemical and physical properties of fruits and vegetables by measuring the reflectance, transmittance, absorbance, or scattering of polychromatic or monochromatic radiation from the sample's surface in the ultraviolet (UV), visible (Vis), and near-infrared (NIR) regions of the electromagnetic spectrum. However, the application of the NIR region (780 to 2500 nm) is especially compelling because it is sensitive to overtones and chemical bond combinations such as C–H, O–H, and N–H, which are abundant in foods. Furthermore, NIR spectroscopy can measure multiple quality attributes of foods at the same time.

Some researchers have demonstrated that NIR spectroscopy has a high potential for detecting insects or insect damage in food commodities such as blueberries, cherries, figs, and green soybeans.

Detecting insect infestation in fruits and vegetables is an important application of this technique because it improves detection accuracy beyond random sampling, which is currently used, reduces the risk of shipping infested samples, and reduces the cost of processing expended on an undetected infested sample that enters the supply chain. The HSI technique can detect hidden internal damage caused by insect infestations without destroying the sample.

IV. RESULTS AND OBSERVATION

An HSI system consists primarily of a visible and near-infrared light source, a wavelength dispersive device, also known as a spectrograph, and a camera that is either a charge-coupled device (CCD) or a complementary metal-oxide semiconductor (CMOS). Data is collected in a variety of scanning modes. Figure 1 depicts a complete setup of the push-broom HSI system. The line scanning or push-broom mode is the most common mode of data acquisition via an HSI system. Figure depicts the other three HSI scanning modes: point scanning, area scanning, and single shot.

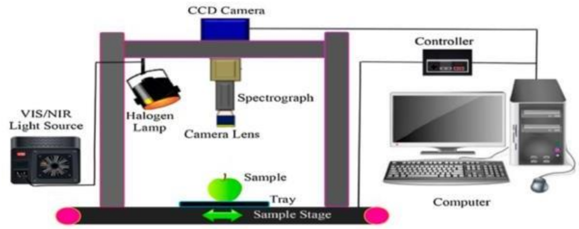

Figure 1. Components of Proposed HIS System

In a push-broom/line scanning system, the imaging system scans the entire field of view line by line and generates a two-dimensional image at the end of each scanning, with the first dimension containing spatial information and the second providing a full spectrum from a specific spot on a sample. Spectra can also be collected in various forms, such as reflectance, absorbance or transmittance, and interactance modes. Each form is chosen based on the sample's type and dimensions, as well as the location of the light source, spectrograph, and camera.

V. CONCLUSION

The consequences of ineffective insect infestation detection in fruits and vegetables are far-reaching. It is found in the reduction in the value of produce that can occur when they enter the supply chain without detection and control, the economic losses that can occur when infestation causes a ban on produce export, the spread or damage to high-quality produce, and the safety issues associated with consuming or processing infested produce. This paper reviewed various methods that have been investigated in recent years for the non-destructive detection and classification of fruits and vegetables infested with various types of insect pests.

VI. REFERENCES

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