A review on Application of Non destructive Inspections Techniques for Evaluation of Agricultural Products

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1/ Introduction

As the health hazards increases day by day due to the consumption of these artificially ripened fruits, it is essential to perform qualitative and quantitative analysis of the presence of detrimental ripening agents within the fruit-skinand flesh to identify with the relevant health hazard. The existence of artificial ripening agent is usually encountered on the fruit skin. But it is also very important to reckon the presence of detrimental chemicals within fruit-flesh and to learn the impact of these chemicals on the food value of artificially ripened fruitsthe fruit quality detection methods which were based on one of the following properties: optical properties, sonic vibration, machine reflection, transmittance and diffuse reflection, and vision technique, nuclear magnetic resonance (NMR), electronic noses, electrical properties, computed tomography. At last, the main problems of non-destructive detection in application were also explained (1) In a brief definition, the qualitative and quantitative measurements in agricultural products and processed food that has been surveyed without any physical, chemical, thermal and mechanical damages to cycle back is called non-destructive test. Diversity andabundance of the parameters and qualitative features of agro-products were the most reason of Nondestructive development methods in recent four decades with the growth of the technology ofthe accurate measuring instruments. Nondestructive tests should not be detrimental effects on the product and it should be in order to ensure customer satisfaction of products. Various non-destructive methods have been described in table 1.

Table 1. Non-destructive methods to evaluate the quality characteristics of agricultural and food products

Scientific basis	The method used	Measurable features
Optical	Image Processing Spectroscopic reflectance, transmission and absorption, laser spectroscopy	Size, shape, color, outward defects ugar, acidity, soluble solid content, color, internal and external defects, stiffness
X-Ray	imaging X-Ray And CT	The inner cavity structure, the degree of maturity
Mechanical	Vibrational excitation Sound and ultrasound	Stiffness, viscoelasticity, the degree of maturity Stiffness, viscoelasticity, internal ,cavity, density sugar and
Electromagnetic	MRI and NMR And NIR	Sugar, moisture content, the inner cavity
Chemical	E-nose, E-tongue	Acidity, sugar

2/ Inspection of Agricultural Product Quality Using Optical Properties Technique.

In the fruit interior quality inspecting systems and their detecting principle Ying yibin et al. (2004) analyzed three different kinds of measuring methods such as regular elaborated the research and application technology for sugar content, acidity an developed the selecting fruit device which select fruit maturity and color d firmness of fruits.(2) Some scholars in Japan developed the sensor of detection the pear and apple maturity by visible light and infrared spectroscopy, then they quickly, and applied this technology to auto-selecting fruits production line linked the maturity, color sensor, auto-grading, package production line achieved a highly automatized non-destructive grading fruits (He Dongjian et al. 2001(3) Han donghai et al. (2006) detected the internal breakdowns of apples by visible-near infrared spectroscopy (650 nm~900 nm), analyzed the spectra of the apples, and selected three wave numbers 715 nm, 750 nm, and 810 nm as the character wave numbers. The results showed that the correct probability of classification was 95.65% by using the above-mentioned three wave numbers (4)

3/ Inspection of Agricultural Product Quality Using Sonic Vibration Technique .

a/ Measurements of Acoustic

these methods developed were essential for detection of physical damage. For researchers and industry, an exciting prospect arises from a better understanding of internal damage of fruits and vegetables during post-harvest processing and circulation. X-ray analysis magnetic resonance imaging, and laser inspection can now be used to detect the internal damage in some limited application; but not practical for routine damage testing because the equipment is expensive. Like all other technologies, the cost of sonic vibration detection method was reduced sharply, and detection capability was improved highly(Jiang Yueming et al (2000).(5). Acoustic resonance technique is an emerging trend for non-destructive quality evaluation of fruits and vegetables. This technique is based on the response to sound and vibration when the sourceis gently tapped. It can be used to predict the maturity, internal quality, ripening stage and other similar parameters using the audible frequency range of 20 Hz to 20 kHz. The availability of high-speed data acquisition and processing technology has renewed research interest in the development of impact and sonic response techniques (6). Acoustic methods are divided into methods of measuring sound emission, absorption and other methods of determining phase oscillation. All parameter changes are caused by the medium through which the wave is passing .Many people have claimed that the maturity and other qualities of some fruits. Such as apples, melon, and pineapples, can be determined by listening to the sound produced by striking them. Many researchers have tried to verify such claims by studying the acoustic responses of fruits, (7) .Yamamoto et al, (1980) developed non-destructive techniques for measuring textural quality of apples and watermelons based on the acoustic response of the fruits They obtained the natural frequencies of the intact fruit by first recording the sound that is produced by hitting the fruit with a wooden ball pendulum and then performing Fourier transformation expressed as functions of the natural frequency, mass, and the density of the fruit, are significantly correlated with on this sound signal. They found that the natural frequencies of both apples and fruit firmness and sensory measurements.(8).

Salveit et al (1985). Tried to used acoustic methods to determine the maturity of green tomatoes, but they did not obtain conclusive results. (9) Acoustic resonance technique is an emerging trend for non-destructive quality evaluation of fruits and vegetables. This technique is based on the response to sound and vibration when the sourceis gently tapped. It can be used to predict the maturity, internal quality, ripening stage and other similar parameters using the audible frequency range of 20 Hz to 20 kHz. The availability of high-speed data acquisition and processing technology has renewed research interest in the development of impact and sonic response techniques (10) Acoustic pulses are sent from a transducer to an object and then scattered, transmitted or reflected from the object. Because of the wide agro-food product div technique. Quality assurance is crucial for monitoring and evaluating the final agricultural materials and food products to ensure their safety and to ensure that they meet consumer expectations with regard to organoleptic attributes and consistent quality (11-12) .

b / **Measurements of Ultrasonic Technique**

Mizrach, et al (2000) reported that the nondestructive ultrasonic measure might have quantitative relation with the maturity firmness and other quality - related properties of rement system was depended for the assessment of same transmission parameters which avocado and mango fruit. Also they found that the attenuation of the ultrasonic waves transmitted through the fruits tissue changes as a result of the ripening and softening of the fruit during storage (13) . Cheng Ap (2000) reported that, when modeling and experimental analysis on the vibrations of agricultural products of ellipsoidal shape such as water melon and cantaloupe and different vibration characteristics are expected. The result was reveal that the vibrations ellipsoidal fruits are more complicated and also different from those of spherical ones.(14). Barrachina, et al (2 evidence to support the hypothesis that (PAS) plant polyamines could also playas important role in this stress. When the system implementing an ultrasonic 000) indicated that the mechanical stress can be observed in fruits when they are expressed to compression, impact and /or vibration during handling and lines there is some method for nondestructive measurements of internal quality of fruits and vegetables was tested by pair of ultrasonic transducers, one acts as transmitted and the other as a receiver for some transmission of sound wave through the fruits peel and flesh and the reception of the transient signal. The result indicated as follow

(1) It was necessary to choose appropriate range of
.data generally between 15 to 25 force units
(2) .Linear regression was applied for this range
(3) Promising correlations were observed between
.ultrasound response and firmness

1/ It was necessary to choose appropriate range of data generally between 15 to 25 force

2/Promising correlations were Linear regression was applied for this range .units

3/ Jancsok, et al, (1998) observed between ultrasound response and firmness (15) reported that the length/diameter L/D ratio of the fruit has a linear effect at the oblate - prolate modes and large quadratic effect at bending and compression modes on the resonance frequency increases when the young's modules increases. (16) . Sarkar and wolf (1983) conducted an investigation to assess the potential of ultrasonic techniques for quality evaluation of fresh and processed foods. They found that ultrasonic transmission could be used to evaluate the stability of reconstituted orange juice, reflectance

measurements could be used to characterize orange skin texture, and a back-scatter that the technique could be used to detect cracks in tomatoes. However, they also found attenuation coefficient measurements of potato cantaloupe, and apple tissues showed Similar extremely high values with in the frequency range of 0.5 to 1.0 MHZ. (17). results were found by Upchurch et al (propagation velocity, attenuation coefficient, and 1987) who tried unsuccessfully to use 1MHZ ultrasound to distinguish between damaged and undamaged apple . They concluded that, because of the porous nature of fruit tissues, high-frequency ultrasound cannot penetrate deeply into the fruit. For this reason it was difficult to use high-frequency ultrasound to evaluate internal quality of fruits and vegetables.(18) Mizrach et al (1989) observed some success in using low frequency (50 KHZ) ultrasonic excitation to determine some basic a acoustic properties (wave reflection loss) of certain fruits and vegetables.(19). The advantages of ultrasonic methods includes quick measurement and interpretation, penetrating optically opaque materials, accuracy, low cost, freedom from radiation hazards, and the ease of on-line measurement At high frequencies and low power it can be used as an analytical and evaluation tool, and at a very high power it can assist processing.(20)

4/ Inspection of Agricultural Product Quality Using Machine Vision Technique

Technology and computer software and hardware, machine vision system had fast development for fruits quality auto-detection and grading During recent years, the machine vision system has been increasingly used for examination of fruits and vegetables Machine vision technique had an earlier application in agriculture to identify plant species. With the rapid development of image processing especially for applications in quality inspection and defect sorting applications [21]. Computer vision system is recognized as the integration of devices for non-contact optical sensing, computing and decision processes, which receive and interpret automatically an image of a real scene [22]. Itincludes capturing, processing and analysis of two-dimensional images, with other noting that aims to duplicate the effect of human vision by electronically perceiving and understanding an image Ying yibin et al. (2004) explored a methodology for the maturity inspection of citrus with machine vision technology, and used the surface color information identification accuracy was 91% and the ratio of total soluble solid to titratable acid TSS/TA) as maturity indexes of citrus (23). The results stated that at the wavelength of 700 nm, the green surface and saffron surface of citrus were of higher spectral reflection, the difference between them reached the maximum, and the image acquired at this wavelength could be of much color information for the maturity inspection. The test results showed that the In order to evaluate the external characteristics of fruits, t he machine vision non-destructive technique based on red green-blue (RGB) color vision systems have been successfully applied. Color is an important quality factor that has been widely studied (24). The image grading of fruits was achieved in six steps: image acquisition; ground colour classification; defect segmentation; calyx and stem recognition; defects characterization and fruit classification into different quality Classes (25). The machine vision system usually consists of five basic components: a light, an imaging unit, an image capture board, and the appropriate computer hardware .and software [26]. The working principle of machine vision as shown in Figure 1

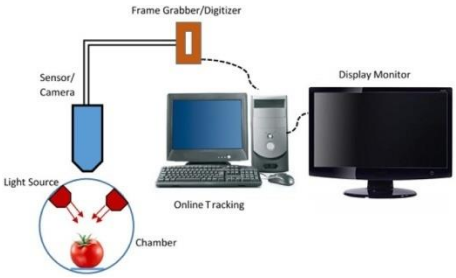

Figure 1. .The basic concept and components of a typical machine vision system

5// Inspection of Agricultural Product Quality Using Nuclear Magnetic Resonance (NMR) Technique.

Nuclear magnetic resonance(NMR) is a technique which detects the concentration of hydrogen nuclei and is sensitive to variations in the binding state. The researchers found that the mobility of water, oil and sugar hydrogen nuclei would change with the change of content in the maturation process of fruits Researchers could measure many parameters of fruits quality using NMR image technique as non-destructive method. The relationship of NMR parameters and fruits quality parameters could be obtained easily, and the development of NMR technique was improved. Although NMR technique had already applied to detecting tumor and other medical fields commercially, the potential of testing fruits defects and other qualities was not totally developed. Therefore this technique has not been reported yet China(Lu Lixin et al. 2004 (27)

6/ Inspection of Agricultural Product Quality Using Electrical Properties Technique.

Some experts…

studied the relationship of frequency properties of fruits electrical properties constant and fruits quality characteristics from 0.1 kHz to 100 kHz in frequency, taking apple and pear as experiment object. The results showed that frequency properties of fruits electrical properties constant and fruits quality characteristics had close relationship. The base of non-destructive detection and auto-grading for fruits was established(Zhang Libin et al. 2000 (28) Guo wenchuan et al. (2007) investigated electrical and physiological properties of peaches in order to understand electrical properties of postharvest fruitss and to explore new quality sensing methods based on electrical properties. It was observed that the relative dielectric constant varied with cosine law roughly and loss tangent decreases as peaches‟ aging The maximum relative dielectric constant appeared at peak of respiration The reasons why electrical parameters change were analyzed. Furthermore BP neural network technology was used to identify freshness of peaches when relative dielectric constant and loss tangent were selected as input characteristic parameters. Results showed the average distinguishing rate was 82% (29).

7/ Inspection of Agricultural Product Quality Using Computed Tomography Technique.

scanning them with X rays and using a computer to construct a series of cross-sectional scans along a single axis. Xu shumin et al. used picked Fuji apples as value and destruction was also different(Xu Shumin et al. 2006 (30) the experiment objects. The layer of X-ray and computer scan was applied to detect the CT value of apples drop from different heights. On the same scan layer , the CT value of destructive apples decreased with Computed tomography increased of storage time, (CT) is a method of examining .and the more destruction was made, the lower the body organs by CT value was. With the increasing the thickness of scan layer, the CT value of non-destructive apples decreased, while the CT value of destructive apples increased. By changing the storage time, the relation between CT Meanwhile, the CT technique was used as the input of neural network to forecast the major components of Fuji apple. The results showed that the average forecast errors of moisture content, sugar content and acid content are 1.75%, 5.81% and 0.72% respectively, and the precision of this method could meet the requirements of Fuji apples non-destructive measurement(Zhang Jingping et al. 2008 (31)

8/ Inspection of Agricultural Product Quality Using Eletronic Noses Technique.

Electronic noses have been developed as systems for the automated detection and classification of odors, vapors, and gases since the end of last century. An electronic nose is generally composed of a chemical sensing system and a pattern recognition system. There was a kind of portable nondestructive detector called Sakata fruits detector in Japan. It could detect the immature, mature and spoiled fruits with 99% accuracy. Zhang libin et al (2000). developed a set of electronic nose system which composed of metal oxide semiconductor gas sensor array by simulating the functioning of the factory system, and analyzed the samples with neural networks. Thdetection accuracy was 80% (32)

9/ Inspection of Agricultural Product Quality Using Hyperspectral Imaging Techniques

Hyperspectral imaging methods have been used for non-destructive evaluation of foodstuff quality. Hyperspectral imaging is also named spectroscopic imaging. A hyperspectrum is an influential spectroscopic system for non-destructive analysis that includes the recording of different numbers of images for different spectral groups Hyperspectral imaging supplies a large pool of data according to the physical and chemical structure of an imaged material. Hyperspectral imaging as a synchronous source for obtaining spatial images in several spectral groups has been reported by Schaepman (33). The hyperspectral imaging system contains a hardware and a software part with specific configuration changes created depending on the material and the image acquisition technique used. The hyperspectral imaging system contains a lighting source, a sensor which concurrently acquires spectra, a spectrograph, and a computer to produce the acquired images as shown in Figure 2 (34) . The applications of hyperspectral imaging in food analysis have been investigated in different studies. Hyperspectral imaging offers advantages such as speed, accuracy, and being a non-destructive analysis

method that can be used along with the different production ways, concurrent valuation, and real-time information processing of a material's chemical and physical properties (35,36).

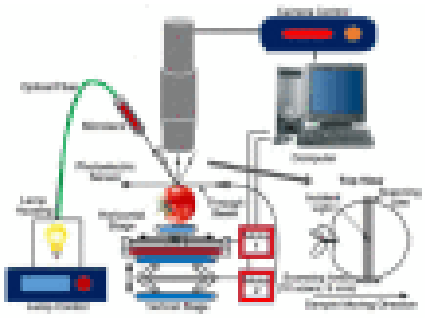

Figure 2. Hyperspectral imaging system for acquiring spatially resolved scattering images from a fruit sample (modified from).

CONCLUSION

The non-destructive inspection methods including optical properties, sonic vibration, machine vision technique, nuclear magnetic resonance(NMR) for agricultural produts quality had distinctive advantage compared to other instrumental comprehensive detection methods for many internal qualities of agricultural products were deficient. With the development of non-destructive detection technique, data-processing technology, automatic control technology and computer technology will play an important role in non-destructive measurement for agricultural products quality. A different technical method was reviewed for inspecting the impact of quality, ultrasonic and acoustic response techniques. Starting with fruits and vegetable properties quality. Visible There are six properties of quality fruits and vegetable, (a) Image processing (b and infrared light energies (c) X-Ray (d) Nuclear Magnetic Resonance (f) Mechanical Stimulation (37).

Keywords: Quality, Nondestructive Techniques, Sensor, Agricultural products.

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