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Study on Near-infrared Spectroscopy Non-destructive Testing of Strawberry Quality

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Abstract: *Non-destructive testing is a technology that has been developed and applied rapidly in recent years. It is widely used in the quality testing of vegetables and fruits, which solves some problems faced in traditional fruit and vegetable testing. As far as strawberry is concerned, this kind of fruit has high market value, but it is not easy to preserve. It is also necessary to conduct non-destructive testing on strawberry quality. It is a detection technology to improve the testing effect and avoid strawberry damage, which plays a positive role in the development of strawberry planting industry. In the non-destructive testing technology of fruits and vegetables, near-infrared spectroscopy is a relatively ideal testing technology. This paper mainly explores the application of near-infrared spectroscopy in the non-destructive testing of strawberry quality, providing ideas for better understanding the application of this technology in strawberry quality testing.*

Keywords: *Strawberry; Quality; Near Infrared Spectrum Detection Technology; NDT*

1. Introduction

The specific characterization of strawberry components can, to a certain extent, reflect the quality characteristics, properties and nutritional components of strawberry, and can also reflect the nutrient loss of strawberry processed products, raw material ratio and process rationality. In other words, the composition of strawberry and other fruits is the most basic element for analysis. In the near-infrared spectroscopy analysis of strawberry components, protein is the most studied part, and is an important factor in the quality control of related products. Secondly, water is also an important part of component analysis, which is a necessary storage control factor and influencing factor for some dry substances; In addition, the determination of fat, sugar, vitamins and other components enables the product to meet consumers' needs and better meet consumers' needs for product taste, sense and nutrition. The composition of strawberry determined by near-infrared spectroscopy is used to comprehensively evaluate the nutrition and quality of corresponding strawberry varieties, so as to meet consumers' understanding of products before purchase, provide basis for strawberry production and processing, and promote the development of food production.

2. Overview of near-infrared spectroscopy non-destructive testing technology

2.1 Detection principle of near-infrared spectroscopy

When materials absorb light energy to promote the transition of molecular vibration from ground state to higher energy state, near-infrared spectroscopy is usually used. Near infrared spectroscopy records frequency doubling and frequency combination information from the fundamental frequency vibration of molecular chemical bonds, which is dominated by frequency doubling and frequency overlap of hydrogen containing groups [1]. In general, the measurement object is the dual frequency and combined frequency absorption of X-H hydrogen vibration. Different groups have different absorption and absorption positions in the near infrared region. Therefore, the number of groups, the nature of groups and the existence of hydrogen bonds will affect the position and intensity of spectral peaks. Therefore, the combination of near-infrared spectroscopy and chemometric methods can determine some properties related to chemical samples, such as concentration, acidity, etc.

In the field of detection technology, the evaluation method of strawberry sensory quality based on near-infrared spectroscopy does not damage the sensory quality of strawberry. The evaluation results are objective and not subject to the subjective influence of reviewers [2]. The specific experimental process includes: obtaining strawberry samples and classifying them; Creating a fuzzy mathematics

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assessment system to assess the correct listening level of the first group; Physical and chemical inspection of the first batch of samples; Reviewing key indicators; Fisher discriminant for sensory level quality model was developed; The second group was analyzed by near-infrared spectroscopy to obtain near-infrared spectral data, in order to determine the significance of the second sample, and develop the quantitative prediction model of key parameters based on near-infrared spectroscopy; The strawberry quality evaluation model based on infrared sensor was used to evaluate the sensory quality level of strawberry [3].

2.2 Advantages of near-infrared spectroscopy in non-destructive testing of strawberries

The advantages of applying near-infrared spectroscopy nondestructive testing technology in strawberry quality testing are mainly reflected in the following aspects:

First, it is green, clean, pollution-free and easy to operate. The near-infrared spectrum nondestructive testing of strawberry must destroy the strawberry sample and also use detection reagents. The detection target can be achieved by collecting the spectral signal of strawberry. Therefore, this detection process is clean and environment-friendly, and the quality of strawberry can be detected by this detection technology. The sample can be directly detected without treatment, and the operation and application are very convenient [4].

Second, precision and efficiency. The application of near-infrared spectroscopy nondestructive testing technology in strawberry quality detection can directly determine the sample through diffuse reflection technology. In the specific technical analysis, the quantitative and qualitative analysis model is constructed through the application of multivariate correction method, so that the effective detection can be completed in a short time, with high accuracy and small error of the detection results.

Third, the cost is low. The near-infrared spectroscopy nondestructive testing technology is used to detect strawberries. Generally, only the near-infrared spectrometer is needed. The price of such instruments and equipment is not high, and no other processes are needed in the detection. The sample is directly tested, with low operating costs. Moreover, the automation level of relevant testing instruments is also constantly improving, which can meet the skill requirements of operators and make the testing results accurate and reliable.

At present, in strawberry quality monitoring, it is common to use HSXD-2100 desktop fruit near-infrared spectroscopy analyzer for detection. Based on near-infrared spectroscopy measurement technology and chemometric analysis technology, near-infrared spectroscopy analysis technology has the characteristics of nondestructive, fast, resource saving, environmental protection, qualitative and quantitative analysis, and is an ideal means for rapid on-site screening, process monitoring, and quality assurance [5]. HSXD-2100 is a desktop fruit near-infrared spectrum analyzer launched by Henan Huashang Brothers Science and Technology Co., Ltd., which can realize non-destructive, rapid qualitative discrimination and quality analysis of fruit on site, and provide a strong guarantee for fruit planting management, picking grading, disease screening, storage and transportation management and other links. This testing instrument has a variety of use characteristics, which can achieve nondestructive testing of samples. It does not need to damage the fruit, does not affect the commercial circulation, and can also measure samples quickly. The testing time can be up to 5 seconds. The instrument and equipment have a variety of specifications for sample testing accessories, which can meet the requirements of multi morphological fruit testing [6]. The use of near-infrared spectrum nondestructive testing instrument can achieve: first, germplasm protection: non-destructive testing of fruit breeding; Second, planting management: fruit growth process monitoring, modern cultivation, fertilization, and picking powerful guarantee; Third, disease screening: internal disease screening such as water heart disease, browning, black heart disease, and regular inspection for storage and circulation. It has certain application value for various production and development work.

3. Specific process of near-infrared spectroscopy nondestructive testing technology in strawberry quality testing

To detect strawberry quality, near-infrared spectroscopy non-destructive testing technology is used. The specific measurement mode is divided into reflection and transmission. The near-infrared light shines on the strawberry sample. The frequency doubling and combination of hydrogen containing tube functional groups such as sugar, acid, pectin, cellulose and vitamin in the strawberry sample absorb the spectral lines at a specific frequency, while other functional groups cannot be absorbed. Based on this,

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the multiple regression metrological analysis can detect the specific organic components and water content more accurately and quickly from the absorption spectral lines. Considering the double frequency and combined frequency corresponding to the near-infrared absorption peak, the corresponding spectral peak width and overlap are also obvious, and the correlation between the related variables is high. The accuracy of the test results can be ensured by constructing the corresponding quantitative and qualitative models through the multiple regression analysis of chemometrics [7]. At this stage, the partial least squares method is a commonly used method, which is a new multivariate statistical data analysis method. It can solve the problem that the number of samples is less than the number of variables, and study the regression modeling of multiple independent variables with multiple dependent variables. Especially when the related variables are highly linear, this regression analysis method is better.

The process of quantitative analysis of relevant components in strawberry varieties using NIR's partial 20% regression is relatively simple, which can be divided into two key steps. The first step is to build a mathematical model in combination with the corresponding requirements, and to test, modify, transfer and optimize the model to ensure the stability and effectiveness of the model. This method is different from the conventional analysis technology. Near infrared spectral analysis is mainly used to extract weak information from complex, overlapping and changing spectra. Therefore, in model construction, it is necessary to process and analyze the cash series spectral data, such as spectral multiple scattering correction, derivative calculation and other operations, to continuously reduce the impact of infection factors and improve the model's transplant function. It is also necessary to evaluate the advantages and disadvantages of the model by checking the sample detection and comparing the known parameters to the indicators such as cross validity, residual and determination coefficient. Finally, the constructed quantitative model is applied to test the unknown samples, and its composition and content are analyzed to verify the effectiveness of the model.

4. Application status and development prospect of near-infrared spectroscopy nondestructive testing technology in strawberry quality testing

4.1 Application status of near-infrared spectroscopy nondestructive testing technology in strawberry quality testing

The near-infrared spectroscopy nondestructive testing technology is used for strawberry quality detection. It has many advantages, such as fast technical analysis, high efficiency, no pollution, low cost, and many advantages. Therefore, it has been increasingly used in the quality detection of strawberry and other related fruit materials. However, there are also some problems in the specific application of this technology. In the operation of sample collection spectrum, the near-infrared spectrum nondestructive testing technology will be interfered by temperature, noise, miscellaneous light, etc. For this problem, it is generally necessary to use the stoichiometric method to improve the prediction accuracy of the model, but such treatment will lead to the development of near-infrared spectroscopy technology being limited by this method [8].

Secondly, according to the research on near-infrared spectrum nondestructive testing technology for strawberry quality detection, most of the research is carried out through more static laboratory analysis, while the research on dynamic factory online testing is relatively few.

In addition, whether the specific model of strawberry quality detection model based on near-infrared spectroscopy nondestructive testing technology has universality is uncertain, and the number of samples collected for strawberry quality indicator detection has not formed a corresponding standard. Near infrared spectroscopy (NIRS) nondestructive testing technology can not accurately detect some low content components in strawberry quality.

4.2 Development prospect of near-infrared spectroscopy nondestructive testing technology in strawberry quality testing

In recent years, the research on the application of near-infrared spectroscopy in fruit quality detection has been increasing, and the related research has also made some achievements. A unified understanding has been formed on the application of near-infrared spectroscopy in fruit quality detection. However, the research also found that the application of near-infrared spectroscopy in non-destructive testing of fruits is still restricted by many factors, and the following research should be carried out in this regard:

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First, in the non-destructive testing of fruit quality, it is necessary to formulate a unified sample collection quantity and standard to ensure the standardization of operation.

Second, a comprehensive fruit quality detection data platform is built based on near-infrared spectroscopy technology to provide support for online detection of related fruits.

Third, at present, the non-destructive testing of fruits is mainly applied not only to near-infrared spectrum testing technology, but also for many other testing technologies, which can also achieve the effect of non-destructive testing. Different testing technology applications have their own advantages and disadvantages. In the detection of strawberry quality, we can consider using multiple detection technologies to achieve the continuous optimization of the corresponding detection model and ensure the continuous improvement of detection accuracy. For example, electronic nose technology and high performance liquid chromatography technology are used in the detection. Through the integration and optimization of multiple technologies, the benefit of nondestructive testing is improved and the deficiency of single detection technology is remedied. In a word, based on factors such as technology application object, site, economic cost and scope, it is reasonable to select non-destructive testing technology for fruit quality, which has a great impact on relevant quality testing, market supervision and production development.

5. Conclusion

The application of traditional strawberry quality detection technology needs to cut samples of strawberries, and then determine their main components and content through the experiments of corresponding reagents and solutions. This process is time-consuming, laborious, and requires the use of many instruments and equipment. The detection cost is high. Moreover, such detection can only detect the corresponding quality of the sample part, cannot reflect the quality of the whole strawberry, and is not universally representative. Therefore, it is not an ideal detection technology. The near-infrared spectrum detection technology can detect the quality of strawberry in an all-round way without destroying its individual integrity, and can accurately and comprehensively detect the sugar content, acidity, vitamin and other elements of strawberry. The detection operation is simple and the cost is low. It is a kind of non-destructive detection technology for fruit that is worthy of application and promotion. From the current technology development trend, the nondestructive testing technology is still further developed and improved. In the future non-destructive testing of fruit quality, it can also promote the continuous optimization of corresponding analysis models and improve the accuracy and effectiveness of nondestructive testing by integrating multiple nondestructive testing technologies.

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References

[1] Cai D, Tang C, Liang Y. etc. The quantitative analysis model of strawberry soluble solids content integrated with near-infrared spectroscopy and color parameters was constructed [J]. Food and fermentation industry 2020; 46(7):218-224.

[2] Niu X, Shao L, Zhao Z. etc. Study on near infrared spectroscopy nondestructive identification of strawberry varieties based on BP-ANN [J]. Spectroscopy and spectral analysis 2012; 32(8): 2095-2099.

[3] Cai D, Peng B, Zeng C, etc. Study on the determination of soluble solid content in strawberry by near-infrared spectroscopy combined with CARS-PLS model [J]. Anhui agricultural science 2020; 48(8): 185-188.

[4] Zhang J. Research on near-infrared spectral detection of strawberry sugar content based on SPXY-WT-CARS algorithm [J]. Food and fermentation technology 2020; 56(6):136-139,142.

[5] Ai S, Liu M. Study on near-infrared spectral detection of strawberry acidity using genetic algorithm combined with interval partial least square method [J]. Acta Agriculturae Universitatis Jiangxiensis 2010; 32(3):633-636.

[6] Shi J, Zou X, Zhao W, etc. Study on characteristic wavelength selection of near-infrared spectrum

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by BiPLS combined with simulated annealing algorithm [J]. Journal of Infrared and Millimeter Waves 2011; 30(5):458-462.

[7] Li J, Guo Z, Hang W, etc. Using CARS and SPA algorithm to screen variables and samples in NIR spectral prediction model of strawberry SSC content [J]. Spectroscopy and spectral analysis 2015; (2): 372-378.

[8] Luo J, Yang Z, Yang L, etc. Estimating model of chlorophyll content in strawberry leaves under high temperature at seedling stage based on hyperspectral parameters [J]. Agrometeorology in China 2022; 43(10):832-845.