

Overview of Quality Evaluation of Fruit and Vegetable Agricultural Products

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Abstract There are many factors affecting the quality of fruit and vegetable agricultural products, such as environmental factors and agricultural management measures. The influencing factors and quality evaluation methods of fruit and vegetable agricultural products were summarized, and its development trends were prospected.

Key words Fruits and vegetables; Influencing factor; Evaluation method; Current situation and trend

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With the development of modern agriculture in China and the improvement of people's consumption level, consumers have higher and higher requirements for the quality of edible agricultural products, especially fruits and vegetables. On the premise of ensuring quality and safety, the appearance, nutritional quality and flavor characteristics of fruits and vegetables have received more attention, and the market has gradually tilted towards fruits and vegetables with high nutritional quality and strong flavor characteristics. Therefore, to improve the quality of fruit and vegetable agricultural products and produce more high-quality fruit and vegetable agricultural products is not only to meet people's needs and market demand, but also an important driving force for the high-quality development of agriculture, and the establishment of a scientific agricultural product quality evaluation system is the basis for improving the quality of agricultural products.

Factors Affecting the Quality of Fruit and Vegetable Agricultural Products

Environmental factors

Environmental conditions play a vital role in the growth of crops. Even for the same variety of crop, the slightly different seasons in different regions will lead to great differences in the quality of agricultural products.

Climatic factors such as temperature, humidity and light significantly affect the growth and development process of fruits and vegetables, thus affecting the accumulation of nutritional components in corresponding fruits and vegetables, which in turn leads to differences in nutritional quality and flavor. Keeping the temperature within a reasonable range is beneficial to the growth of crops. When the temperature is too high, it will cause high temperature stress to crops, which will affect the physiological activities of crops. For example, high temperature inhibits the elongation of roots, thus limiting the absorption of water and nutrients by crops and affecting the physiological process of hormone synthesis and transportation^[1], which will eventually lead to yield reduction or quality decline. Temperature rise will have a significant impact on the quality of fruits and vegetables, changing the content of nutrients in fruits and vegetables, such as reducing the sugar content of tomatoes and melons and the carotene content in Chinese cabbage^[2-3].

In terms of humidity, in a suitable humidity range, fruits and vegetables grow well. When the humidity is too low, the soil is dry, and plants are prone to dehydration and wilting. If the humidity is too high, fruits and vegetables may grow in vain, and it is easy to induce diseases such as fungi and bacteria, which spread quickly.

In terms of light, suitable light conditions can promote the growth of fruits and vegetables and increase the content of nutrients, such as the synthesis of carotenoids and vitamin C in tomatoes^[4]. Red light can significantly promote the increase of volatile substances in tomato fruits^[5].

Agricultural management measures

Agricultural management measures also have an important impact on the nutrition and flavor quality of fruits and vegetables. Fertilization methods, irrigation management, and harvesting time

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will all affect the growth and final quality of fruits and vegetables.

Reasonable fertilization strategies can promote the healthy growth of fruit and vegetable crops, and especially improve their nutrient contents^[6]. Nitrogen is the most important nutrient element for plant growth and development. Appropriate application of nitrogen fertilizer will make crops grow vigorously. Phosphorus can participate in energy metabolism in plants and maintain cell membrane structure. When phosphorus content is insufficient, it will lead to higher respiratory intensity of crops, cause fruits to rot and deteriorate easily, and affect fruit coloring, as well as reducing sugar content. Potassium plays an important role in plant photosynthesis and transportation of photosynthetic products. Appropriate application of potassium fertilizer can not only increase tomato yield^[7] and improve quality, but also enhance appearance, quality, disease resistance and storage tolerance of fruits and vegetables.

Irrigation management plays an important role in regulating the growth and development of fruits and vegetables^[8], and irrigation time and amount have great influence on the quality and disease resistance of fruits and vegetables. Insufficient water supply will affect the normal growth and development of fruits and vegetables, which will eventually lead to a decrease in yield and quality and susceptibility to infection by pathogenic bacteria. For example, the lack of water in peach fruit before harvest will lead to hard flesh, low yield and poor taste. However, excessive water supply will prolong the fruit growth period and make the flavor weak and the color poor, and the fruits are prone to decay.

The harvest time of crops varies with their species and growth cycle, and it is possible in all seasons. The harvest time and quality are deeply influenced by many factors, and the specific time varies with varieties and growing environment. Studies show that harvest time significantly affects the quality of fruits and vegetables. For example, the contents of soluble solids and vitamin C in tomatoes are greatly affected by different harvest time, and the soluble solids content first increases and then decreases with the delay of harvest time^[9].

Quality Evaluation Methods

Sensory evaluation methods

The appearance of fruit and vegetable agricultural products is an important commodity property, and fruit and vegetable agricultural products with good fruit shape, large size and suitable color are more likely to be favored by consumers. Sensory evaluation method is often adopted to evaluate the appearance of fruits and vegetables. Sensory evaluation method is a method for professionals to evaluate the appearance and taste of agricultural products through sensory organs such as eyes, nose and mouth according to the procedures and methods of national standards for sensory analysis. Traditional evaluation methods that rely on observation by naked eyes, smell and touch are often influenced by human factors, and it is difficult to fully reflect the quality characteristics of fruits and vegetables. In recent years, with the development of

technology, on-site rapid detection methods such as instrument determination and electronic sensors are also widely used^[10]. For example, the color of fruits and vegetables can be evaluated by a colorimeter. Viscosity can be evaluated by a viscometer. The odor can be evaluated by an electronic tongue or electronic nose. And water content can be evaluated by near infrared spectroscopy. Physical properties such as freshness and cell wall hardness can be evaluated by electrochemical sensors. These advanced techniques make the quality evaluation of fruits and vegetables more accurate and comprehensive, and multiple factors affecting quality are taken into consideration at the same time, thus obtaining comprehensive evaluation results.

Evaluation methods of nutritional quality

For the evaluation of nutritional quality of fruit and vegetable agricultural products, conventional laboratory testing methods are often used. Generally, professionals carry out experimental operations according to the procedures and methods of the current national standards for corresponding nutritional indicators to obtain corresponding data, analyze and process the data, and finally draw a conclusion. Common nutritional quality indicators, such as vitamin C, can be determined by high performance liquid chromatography with reference to *National Food Safety Standard: Determination of Ascorbic Acid in Foods* (GB 5009.86-2016). Soluble solids can be determined by the refractometer method with reference to *Determination of Soluble Solids in Fruits and Vegetables; Refractometer Method* (NY/T 2637-2014). Carotene can be determined by high performance liquid chromatography with reference to *National Food Safety Standard: Determination of Carotene in Foods* (GB 5009.83-2016). The Kjeldahl method can be used for routine protein determination. The Soxhlet extraction method can be used for fat determination. Amino acids can be scientifically determined by the amino acid analyzer method.

Present Situation and Trend of Quality Evaluation

Present situation

In recent years, China has attached great importance to the quality of agricultural products, especially fruits and vegetables. The *Implementation Plan for the Promotion of "Three Products and One Standard" in Agricultural Production* issued in 2021 and the *Notice of the Ministry of Agriculture and Rural Affairs on Implementing the Four Actions of "Three Products and One Standard" for Agricultural Products and National Plan for Improving the Quality and Safety of Agricultural Products in the 14th Five-Year Plan*^[11] issued in 2022 all reflect that the importance of building a well-known brand and improving the quality of agricultural products for the high-quality development of agriculture by guiding variety cultivation and standardized production through quality demand has reached an unprecedented height. In addition to formulating relevant policies, China has also launched a special task of evaluating the quality of agricultural products to guide the high-quality development of agriculture with quality improvement.

At present, the quality evaluation of fruits and vegetables in China still plays a role in the form of quality standards at all levels, generally including agricultural product quality grading or grade specification standards^[12]. In the past decade, China has formulated a large number of quality grading or grading standards for agricultural products such as grain, vegetables, fruits, meat and eggs. In order to improve the quality of agricultural products on the market, many industries have already begun to formulate their own industrial grading standards of quality. In the actual production and sales of agricultural products, simple and convenient agricultural product quality evaluation methods or means are generally adopted to classify agricultural products according to certain classification standards. However, there are some problems at present, such as the lack of endogenous motivation to improve the quality of agricultural products, unclear quality level and quality characteristics of fruits and vegetables, imperfect standardization of quality testing and evaluation methods, imperfect quality evaluation platform and personnel team, and insufficient supporting projects and development funds.

Trends

Constructing a comprehensive quality evaluation system for fruits and vegetables There are abundant variety resources of vegetable agricultural products in China, and there are great differences in quality characteristics due to different climate and geographical environments, which makes it difficult to construct a comprehensive quality evaluation system for fruits and vegetables. In order to solve related problems, we should construct a corresponding comprehensive evaluation system for fruit and vegetable quality classification according to the various subdivided quality characteristics of fruits and vegetables. We should clarify the evaluation methods of fruit and vegetable quality, form a scientific and systematic comprehensive evaluation system of fruit and vegetable quality, and provide professional support for fruit and vegetable quality classification. According to the characteristics of the industry and the trend of consumption demand, the quality indexes of fruit and vegetable quality grading should be screened, and a quality grading system adapted to the needs of industrial development should be constructed.

Excavating the characteristic quality of high-quality fruits and vegetables For high-quality characteristic fruits and vegetables, such as geographical indication products and green products, effective quality characteristic identification indicators have not yet been fully explored, resulting in a lack of unified standards for identifying high-quality fruits and vegetables and the inability to form a high-quality fruit and vegetable business card, which are not conducive to unified supervision and lead to a mixed quality of products in the market, and the advantages of geographical indication products have not been fully utilized. Therefore, from the aspects of sensory quality, nutritional quality, commodity quality and processing quality, sensory evaluation and nutritional index screening should be carried out, and characteristic quality indexes should be comprehensively screened to build a comprehensive

evaluation system of high-quality characteristic fruits and vegetables, which is conducive to building high-quality fruit and vegetable brands and promoting high-quality agricultural development.

Intelligentizing quality evaluation Precise and multi-dimensional evaluation have become the main trends in the development of fruit and vegetable quality evaluation, which requires more intelligent and information-based quality evaluation technology. In recent years, China has devoted itself to a lot of characteristic quality analysis and mining in bulk agricultural products, and established a quality evaluation database. The development of information and intelligence has promoted the high efficiency and real-time evaluation of fruit and vegetable quality. The rapid development of modern agriculture puts forward higher requirements for fruit and vegetable quality management. It requires not only more accurate quality evaluation, but also real-time monitoring and management in production, transportation and storage. The application of Internet of Things technology, sensors and big data analysis makes the quality monitoring and management of fruits and vegetables more intelligent. For example, temperature and humidity sensors can monitor the storage conditions of fruits and vegetables during transportation in real time, and judge whether they meet the best storage environment through data analysis, thereby avoiding quality degradation caused by improper storage. Meanwhile, through the analysis of big data, we can predict the quality of fruits and vegetables, identify possible quality problems in advance, and then take corresponding measures. Such intelligent management not only improves the efficiency of quality evaluation, but also reduces human intervention and improves the accuracy and reliability of data.

Standardizing quality evaluation Scientific and effective quality evaluation systems play an important role in improving the quality of fruits and vegetables. Because of the regional and variety differences of fruits and vegetables, it is urgent to establish subdivided evaluation standards and conduct quality evaluations based on regions and standards. In view of the low standardization of existing quality inspection and evaluation methods, it is urgent to develop the standards of conventional quality inspection and evaluation methods and supporting standard samples in the future, and strengthen the standardization of quality inspection and evaluation method systems. The standardized application of new food detection techniques in fruit and vegetable quality evaluation can be conducted. It is necessary to increase efforts to carry out fruit and vegetable quality evaluation continuously, improve multidimensional quality data, and provide technical support for high-quality fruit and vegetable production and quality evaluation.

Specializing the talent team of quality evaluation At present, there is a serious shortage in the construction of personnel team for fruit and vegetable quality evaluation and grading^[13]. The demand for talents for quality evaluation of fruits and vegetables is different from that for safety inspection. Quality evaluation requires talents who are familiar with professional fields. At present, safety inspection personnel are mainly those who are familiar with chemical

analysis such as chromatography and mass spectrometry, and there is a lack of talents familiar with product characteristics in food science, agricultural product storage and processing, *etc.* They cannot accurately grasp the quality indicators and evaluation of fruits and vegetables. Therefore, on the basis of existing testing personnel, relevant fruit and vegetable quality testing and evaluation personnel should be recruited or trained to carry out the laboratory work of fruit and vegetable quality evaluation. In addition, according to the implementation requirements of fruit and vegetable quality grading work, relying on technical personnel of agricultural quality inspection stations in various provinces, cities and counties, a group of on-site graders for agricultural product quality evaluation in the field should be trained to establish a special team of graders for fruit and vegetable quality evaluation.

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