Optimization of Food Quality Inspection Technology Based on Color Analysis

Chengsong An, Birong An, Zhongwen Pan, Lihua Ou
Tianjin Agricultural University, Tianjin, 300384, China

Abstract: With the continuous development of food culture, the issue of food quality and safety has received constant attention. The operation process is easily affected by human factors and external light, resulting in low accuracy of inspection results, which is the main drawback of using traditional food quality inspection technology. In this regard, this paper designs a new food quality inspection and optimization technology. Through the preparation of the adsorption column, the food surface inspection sample is extracted; through the optimization and calibration of the chromatograph structure, high-precision chromatographic images are obtained, a color model is established based on the principle of color analysis technology, and the color characteristics of the extracted sample chromatographic image are determined to achieve high-precision food quality measurement. Experimental research shows that the newly designed food quality inspection technology based on color analysis is more accurate and has a shorter inspection time than traditional inspection technologies.

Keywords: Food quality; Sample extraction; Color characteristics

1. Introduction

In recent years, the number of food quality and safety incidents in China has gradually increased. People attach more importance to food quality and health. Food quality inspection is the key to ensuring food health. Food colors are the most intuitive and are one of the basic criteria for people to evaluate the quality of food. In this regard, based on the traditional food quality inspection technology, a new color measurement instrument's color analysis optimization technology is proposed. Compared with traditional technologies, which have large differences in inspection results and unreliable data, this new food quality inspection technology is based on color measurement instrument's color analysis technology, and uses image processing systems to obtain food quality inspection results by taking the external characteristics of food as the basic reference. It can not only improve the inspection accuracy, making the inspection results more authentic and credible, but also is more sensitive than the traditional inspection technology in the collection of food color information. In addition, the newly designed food quality inspection technology is not destructive, to a great extent to avoid damage to the external structure of the food, so the food can be re-examined, which is more suitable for large-scale food quality inspection and rating.

2. Design of Food Quality Inspection Technology Based on Color Analysis

2.1. Preparation of food sample extraction column

The newly designed food quality inspection technology requires to collect the food samples firstly. Most of the traditional food sample collections are conducted in simple tubes, which has poor protection to the samples and large inspection errors. The newly designed food inspection technology uses GDX resin and Tenax-TA adsorption tube to make and prepare a high-seal food adsorption column to store food samples. In the actual production of GDX resin, some chemical raw materials or organic impurities may be remained, so when make and prepare the adsorption column, GDX resin must be purified to remove residual impurities in the resin during preparation or storage. The specific purification method is: the GDX resin is placed in a qualitative filter bag for chemical use, and then the filter bag is put into a Soxhlet tube extractor, and then it is filtered and extracted with methanol (CH_3OH), acetone (CH_3COCH_3) and methane dioxide (CH_2Cl_2) respectively, the extraction time is about 10 hours, and the extraction rate of each extraction solvent is controlled at 8 times/h. The purified GDX resin and methanol are mixed again to form a thick paste, which is put into a previously prepared Tenax-TA adsorption tube whose both ends are fixed with ink cotton by slurry wet method. The overall filling height of the resin needs to be greater than 100 mm and less than 150 mm. After the filling is completed, the methanol is withdrawn to ensure that the liquid level matches the surface of the resin bed, and then the residual methanol in the adsorption column is removed by means of distilled water to ensure that the level of distilled water is slightly higher than the surface of the resin bed, and the adsorption column is declared to have been prepared.

2.2. Chromatography inspection and calibration

According to the food inspection theory basis and the food quality inspection criteria included in the Langebier's law, in order to improve the chromatograph inspection accuracy, it must be upgraded. According to Langebier's law, the formula for absorbance can be derived as follows:

$$\frac{\Delta G}{G} = \frac{0.575\Delta T}{T1gT} \quad (1)$$

In formula (2), G is the best chroma value; ΔG is the absorbance change value; ΔT is the established food sample concentration. Regardless of whether the color is too high or too low, it can cause large errors in the results. Especially in the water quality solution that needs to be inspected, if the water quality parameters are too complex or the overall parameter content is large, the standard curve of the chromatograph may be bent, which may affect the inspection results. Therefore, the design uses a standard working curve with a chroma of 0.5 to 0.9 as a whole. In order to improve the measurement accuracy, the food sample solution is subjected to dilution pretreatment and denoising operation to improve the sensitivity and accuracy of the inspection of the food sample by the chromatograph.

2.3. Upgrade of chromatograph structure and acquisition of inspection result

This design adopts a new structure of the food quality analysis system with multi parameters of the new chromatograph, mainly including: the main flow path and auxiliary flow path of food samples, standard light source, hue reaction and so on. The overall structure is shown in Figure 1.

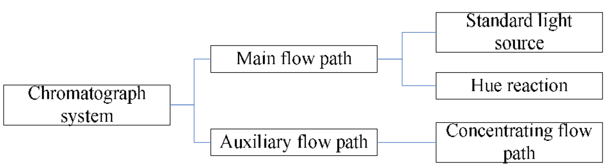

Figure 1. Inspection system structure.

The food sample solution and solution reagents enter the mini sample reaction chamber through the main flow path structure, and undergo digestion and chromatographic inspection operations in the reaction chamber. The hue reaction chamber has the functions of automatic control, constant temperature, automatic stirring solution, ultrasonic output and automatic cleaning. The flow path system is mainly divided into a main flow path and an auxiliary flow path. The main flow path is mainly used for the extraction and transportation of sample reagents, and the auxiliary flow path is mainly responsible for conveying air bubbles to ensure oxidation reaction. The chromatograph in the inspection system can output the chromatograph data of the inspection sample, and calculate and check the content of various water quality parameters in the food sample. The wash processing system mainly uses the embedded single-chip microcomputer control system as the core and completes the overall monitoring signal output. As the upper computer, the control system can also regulate power switch, power flow and sample chemical treatment [4].

When the aqueous solution of a sample is subjected to a certain water quality parameter for content inspection, the chromatograph inspection system sends the sample solution and the corresponding digestion agent to the sample reaction chamber according to a certain volume ratio through two types of flow path systems, and performs pretreatment before inspection, to achieve the inspection of the content of the sample water quality parameter through chromatograph.

2.4. High-accuracy inspection of results based on color analysis model

The inspection method of traditional technology is subjective. Usually, under certain irradiation conditions, a professional tester obtains the color of the sample by the hue meter, and compare it with the sample food according to the color value provided by the standard swatch, and then gets the color reference value of the inspected food. The reference color values of different food are sometimes set by the expert group, and the grades of the inspected food are evaluated by comparison results. During the inspection process, the personal experience of food quality testers and the intervention of physiological and psychological factors greatly affected the inspection results. Because the human eye has limitations on color recognition, it is unable to sensitively perceive subtle changes in color values, resulting in low accuracy of color recognition data. Therefore, the newly designed food safety inspection technology establishes a color model to obtain the color information of the food surface.

After obtaining the sample images of the hue meter, in order to correctly use the color analysis and reduce the analysis error, a color analysis model needs to be established. A color analysis model is a collection of three-dimensional colors and can also be viewed as a subset of color luminosity. It includes all color partitions of the images of the hue meter. Its main color gamut is a true-color image composed of red, blue, and green color maps. The color model can select a subset of colors in the above-mentioned three-dimensional color gamut with the help of all the colors in color gamut composed by visible light sources generated by the chromatograph. The design adopts RGB color model. The main parameter R is the image chroma, G is the image saturation, and B is the brightness. The target image transformation is the gradation processing of the image color model, which can reduce the calculation of image processing and improve the recognition of feature points. And the goal transformation matrix is designed. Matrix element values represent the gradation value of the corresponding point of the image and it is transformed into a gradation model G (r, r, r). In the original color model, red, green, and blue trichromatic decomposition need to be extracted based on the image information to perform gradation replacement, and the gradation is set to 128, that is, the gradation value is from 0 to 128, and then the weighted average method is used to assign the weighted values according to the proportion of the three primary colors in the original color model, to obtain the high-precision color analysis results finally. The initial color values are then substituted into the program formulas and converted into data that can be analyzed, thereby obtaining a quantitative index for evaluating the quality of food.

3. Experimental Research

In order to test the effectiveness of the newly designed food quality inspection technology, a comparative experiment is designed. 200 eligible Yantai Fushi apples are selected as experimental subjects. The traditional Chinese food quality inspection technology and the newly designed food quality inspection and optimization technology are respectively applied to the inspection samples to determine the quality for them.

The inspected samples have been pretreated before the experiment. All the samples are eligible Yantai Fushi apples with normal shapes, fruit diameter of 75-80 mm, and intact appearances. During the experiment, the ambient temperature is maintained at 20~25°C and the light intensity is 2600 lx. In the experimental evaluation results, the grades are only divided into qualified products and unaccepted products, and it sets that the apple surface coloring rate of 60% or more was qualified.

In the control group, a professional tester uses traditional inspection technology for food inspection. The tester conducts food quality inspection for apples of the control group based on the provided standard swatch. By comparing the color value of the standard swatch with the appearance color of the inspected sample, the apple grades of the control group are determined.

The experimental group uses the newly designed food quality inspection technology. The samples to be inspected are sampled and inspected by chromatograph to generate color images. During this time, the chromatograph will optimize the process different color values to improve the images inspection quality. According to the image information, the color measurement instrument will classify the different wavelengths and determine the wavelength parameters. On this basis, the system will match the calculation formula to inspect the food quality and finally obtain the data results, which is shown in Table 1.

Table 1. Comparison of experimental parameters

Parameters	Comparison group	Experiment group
Comparison time (h)	1.5	0.3
Comparison accuracy	75%	95%
Is there any harm to Apple?	Yes	No obvious harm
Whether to support large-scale inspection	No	Yes

According to the data in Table 1, it can be seen that the newly designed food quality inspection technology based on color analysis has obvious advantages in terms of inspection time and accuracy compared with traditional inspection method. In addition, the newly designed food quality inspection technology is easy to operate, can greatly reduce the labor force, and save food quality inspection costs. Its inspection time is shorter, effectively improving the detection efficiency, meeting the requirements of large-scale food quality inspection and rating, which can help to realize the automation of food quality inspection.

4. Conclusion

With the improvement of people's material living standards, people have higher and higher requirements for food quality, and food quality and safety issues need to be resolved. The application of color measurement instrument’s color analysis technology can help to reduce the occurrence of food quality and safety issues to a large extent. This kind of technology can reduce the impact of objective conditions on the inspection process and help improve the accuracy of the inspection results. The color measurement instrument’s color analysis technology is based on scanning food colors and collecting color templates for image information processing. The use of systematic calculation rules accurately measures the data results, thus providing an objective and fair basis for food quality inspection and analysis. This kind of technology can ensure the integrity of the inspected food and avoid the disadvantages of previous inspection technology that cause damage to food. Therefore, the safety of the inspection process is high and the food can be inspected. This feature is conducive to large-scale food product quality inspection. As a new type of optimization technology, the color measurement instrument's color analysis technology has many advantages, and it can effectively improve the level of food safety if it is applied to food quality inspection.

5. Acknowledgment

National University Student Innovation and Entrepreneurship Project (No.201810061018).

References

[1] Luan Y.X., Zhang Z.N., Chen J.W., et al. Visual detection of cadmium based on aggregation of aptamer-modified gold nanoparticles. Journal of Food Safety & Quality. 2016, 7, 2, 511-516.

[2] Ge Q., Wu M., Zhao Z.D., et al. Comprehensive evaluation and correlation analysis of color quality of new red wine in the eastern food of Helan Mountain. China Brewing. 2017, 12, 34-39.

[3] Cao S., Wang R., Liu Y., et al. Effect of 1-MCP on the Yanhong peach shelf quality based on the principle component analysis. Jiangsu Journal of Agricultural Sciences. 2017, 33, 1, 197-203.

[4] Deng J.K., Liu X., Wu X.Y., et al. Quality Evaluation of Apple (Substandard) Juice from Different Cultivars Based on Analytic Hierarchy Process and Grey Interconnect Degree Analysis. Journal of Chinese Institute of Food Science and Technology. 2017, 17, 4, 197-208.

[5] Shi X.N., Zhao Z.L., Huang F., et al. Changes of the main nutritional quality and eating quality in the process of braised pork. Science and Technology of Food Industry. 2016, 37, 13, 86-91.