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Introductory Chapter: Color Detection

Shi-Lin Cao, Jin-Heng Hao, Wei-Dong Ou-Yang, Zi-Shi Chen, Yong-Si Lv and Ling-Wen Zeng

1. Introduction

Chromogenic assays, also named as color detection, result in colored reaction products. By detecting the color change before and after the reaction, substance concentration could be determined by the naked eye, light microscopes, and spectrophotometers.

Nowadays, a large number of food analyses and biochemical detections could be performed by color detection and were exemplified as below:

Protein is one of the main ingredients of food. Bradford method, developed by Marion M. Bradford in 1976 [1], is the most widely used colorimetric method for protein detection. The anionic dyes used in this method is Coomassie brilliant blue (such as G-250, R-150, R-250, R-350). For example, the Coomassie brilliant blue G-250 exists in three forms with different colors including cationic (red), neutral (green), and anionic (blue). After binding with protein under acidic conditions, the color of Coomassie brilliant blue G-250 dye converts from red to blue, and the protein concentration is assayed. Up to now, the relative reference of the Bradford method was cited by more than 240,000 literature [1].

The reducing sugars could be assayed by using 3,5-dinitrosalicylic acid method (known as DNS method). 3,5-Dinitrosalicylic acid, an aromatic compound, was used as the test reagent and reacted with reducing sugar to form the 3-amino-5-nitrosalicylic acid, since the 3-amino-5-nitrosalicylic acid could strongly absorb light at 540 nm. The amount of the reducing sugar could be measured by spectrophotometry [2–4].

The anthrone method is another colorimetric detection method for both reducing and nonreducing sugars assay [5]. Anthrone is a tricyclic aromatic ketone. In the acidic condition, the anthrone reagent reacts with sugar, resulting in yielding a blue-green color. The absorbance of the above blue-green color solution could be measured at 620 nm.

Phenol-sulfuric acid method is also a colorimetric method for the detection of carbohydrate in food [6]. While reacting with phenol and sulfuric acid, the carbohydrate sample solution to be tested became yellow-orange in color. Since the sulfuric acid converted the nonreducing sugars to reducing sugars, the total amount of carbohydrate could be detected by this method.

The pH indicator paper could be used to measure the acidity of the solution to be tested. The main components of pH indicator paper contain methyl red [pH 4.4 (red)–6.2 (yellow)], bromocresol green [pH 3.6 (yellow)–5.4 (green)], and thyme blue [pH 6.7 (yellow)–7.5 (blue)]. The pH indicator paper that dropped different acidity solution exhibit different color, by using colorimetric card the range of the acidity could be detected naked eye.

The sulfur dioxide as well as sulfite was widely used during the food processing. Sulfur dioxide and sulfite exhibit a high effect in inhibiting nonenzymatic browning in the process of food processing and could be used as preservative to inhibit mold and bacteria. Thus, it is important for the detection of the content of sulfite. The sulfite could be reactive with o-phthalaldehyde under alkaline environment and formed dark blue complex [9]. The sulfite content could be detected by the increase of the absorbance value at 628 nm.

Jabbari [7] developed a sensitive kinetic method for the determination of sulfite (0.05–2.5 µg/ml). There is an addition reaction between methyl green and the sulfite at pH 8 and 25°C. This results in the color fading of the methyl green. Thus, by detecting the decrease in the absorbance of the dyestuff at 625 nm by the fixed time method, the concentration of the sulfite could be spectrophotometrically monitored. The result showed that the limit of the detection and the relative standard deviation are 0.05 µg/ml and 2.88%, respectively.

The phosphorus in food could be detected by phosphor vanadium molybdenum yellow spectrophotometry [8]. Under acidic condition, the phosphorus reacts with vanadium ammonium molybdate and formed a stable yellow color vanadium-molybdenum-yellow.

Apart from the above, color detection exhibits great potential in the field of quality monitoring, chemical technology, nanophysics, and clinical medicine, because of their rapid, direct, specific, convenient, and sensitive features. The intention of this book is to provide readers with a comprehensive overview for the principles, features, and applications of color detection.

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Author details

Shi-Lin Cao*, Jin-Heng Hao, Wei-Dong Ou-Yang, Zi-Shi Chen, Yong-Si Lv and Ling-Wen Zeng*
Department of Food Science, Foshan University (Northern Campus), Foshan, China

*Address all correspondence to: shilin.cao@fosu.edu.cn; zeng6@yahoo.com

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