A Glance at Food Nutrition Components Analysis

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Abstract: With the development of economic, food safety gradually becomes an obvious part drawing our attention in life. As we all know, the food nutrients show closely connection to our human health. Sugar and fat are key players in diabetes, cardiovascular and cancer diseases and millions of people are suffering these diseases. Protein plays a vital role in our body as well, especially for the infants for whom the milk is their main source of energy supply so the quality of these food should be paid tightly attention to. In food industry, the food analysis methods should be diverse, and many well-established approaches already worked well for a long-time history, while during this time new and fantastic techniques always emerging and become a strong competes to the conventional ways. In this article, we will attempt to gather the existing analysis approaches for the main food components and show their advantages and disadvantages.

1 INTRODUCTION

The nutritional contents of food are closely related to human health. Food contains a variety of nutrients needed by the human body, including sugar, fat, protein and so on. In terms of their functions in the body, these nutrients are divided into three parts: constituent substances, energy substances and regulating substances. In the nutritional composition of various foods, only certain components are the same, and the content of these components in various foods is also very different. Therefore, a variety of foods can be combined from these food ingredients, which is the composability of food ingredients. It is precisely because of the combinability that the inherent differences of various foods are created.

With the development of economic, humans gradually noticed that nutrients in food are needed to pay more attention since we all know that all the nutrients are closely to human health. According to this, the industry adopts many hash policy to control the quality of the food to ensure the food safety. From this view, it is important to develop many useful and efficient technique to detect and quantify all the components in food. Due to the differences and complexity of the food matrix, the methods used to detect food ingredients are also diverse, such as chromatography, colorimetry, refraction, and so on. But these methods have their own advantages and disadvantages. With the rapid development of science and technology, the research of food nutrients is gradually deepening, and food testing technology and testing instruments are constantly updated and developed. This enables modern food testing to cope with various complex situations. This article includes the current detection methods of common nutrients in food and their advantages and disadvantages.

2 PROTEIN DETECTION

Typically, the Western Blot (WB) has been used as a traditional way to detect protein(Taylor and Posch 2014). The principle of WB is based on the antibody recognition, and specific band will be got for each specific protein in which quantification is an essential to verify the expression level of each protein (Figure 1 and 2). However, the time costs of this approach are usually 1-2 days which is a disadvantage when compared to others. Even though the approach was improved recently to shorten the time to several hours(Lin-Moshier and Marchant 2013), the way that WB is able to detect several proteins not the total protein contents still make WB not as a popular one used in food protein contents detection.

So for a long time, total nitrogen content was used to the determine the protein content of foods in which Kjeldahl invented a method that has been used broadly to determine the total nitrogen content. But the method still costs a relative long time, researchers

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mainly focused on the time costa to improve the process to make it more efficiently. Recently, a developed method based on an automated instrumental technique was applied in food protein contents detection since it is capable of measuring the food protein concentration in a shorter time than Kjeladahl methods(Stitcher, Jolliff et al. 1969, Wiles, Gray et al. 1998). Even though the technique was developed recently, the technique is based on Dumas's method which was created over a century ago. It is already on its way to compete with the Kjeldahl method since it costs a shorter time without the loss of accuracy.

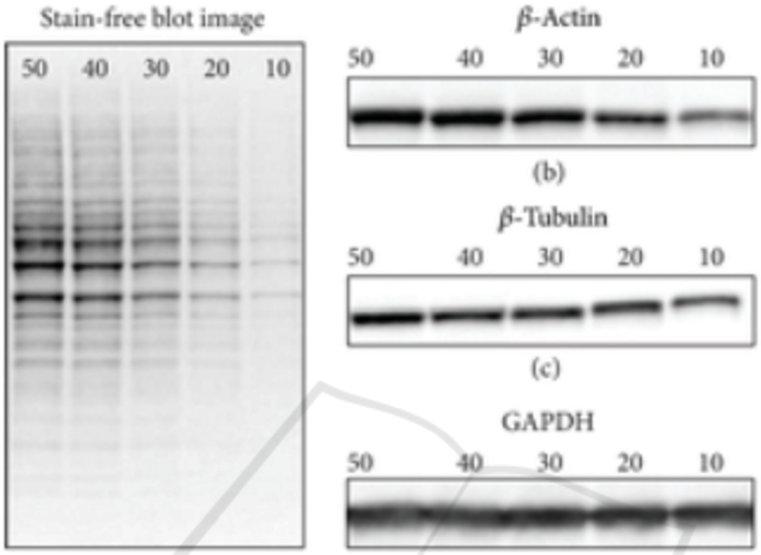

Figure.1: Typical western blot image for probing three different proteins1.

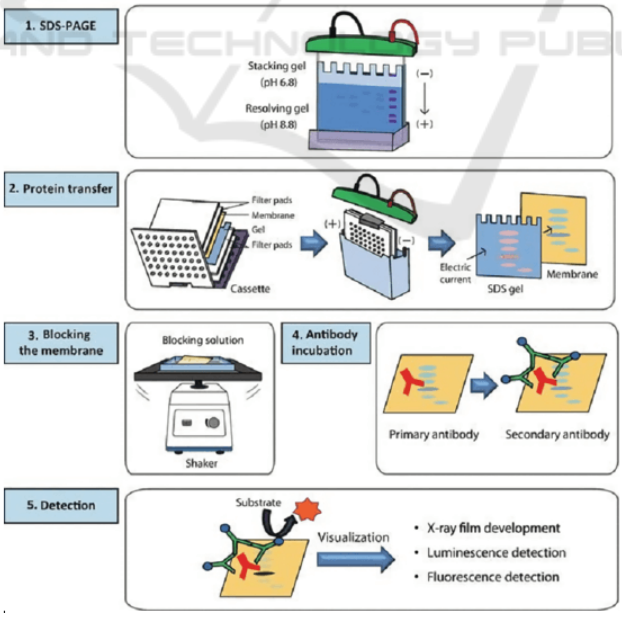

Figure.2: Typical western blot workflow(graph from Creative Biolabs).

3 NUCLEOTIDE DETECTION

Nucleotide is one of the most important biological molecular in nature, although it is not a nutrient in food, it is vital to identify some nucleotides which can be used as markers to some specific species, since bacterial infection can be very harmful to human health. In order to control the contaminations of bacteria, some nucleotide as markers should be detected in food industry.

Polymerase chain reaction (PCR) is a conventional technique to amplify the small segments of DNA, allowing us to have a large amount of DNA to detect(White, Arnheim et al. 1989).the specificity of PCR relies on oligonucleotide primers which are complementary to both ends of the target sequence. PCR typically involves two sequential amplification reactions, in which each uses a different pair of primers. The product of the first amplification reaction is used as a template for the second PCR, which is initiated by the oligonucleotides placed inside the first pair of primers. Applying two pairs of oligonucleotides makes more cycles to be performed, thereby improving the sensitivity of PCR. (Rychlik 1993)

After the PCR is done, the product is separated in a gel and confirm the size of the product so that we can verify that the contents of nucleotide from bacteria or some specific species. However, the whole process usually takes several hours, and the gel separation must be used to confirm the size and the amount of the nucleotide. In order to simplify the whole process and get a better way to quantify the amount of the DNA, real-time PCR (RT-PCR) (Figure 3 and 4) was developed to be applied in the quantification of DNA(Kubista, Andrade et al. 2006).

Fluorescent probes are added in the RT-PCR system when the reaction is done, the amount of DNA can be calculated at once. So all the whole process is completed only in one step as a result that the RT-PCR is applied broadly in DNA quantification.

4 FAT DETECTION

Fat plays a very important role in human health since excessive fat from food can increase the risks of obesity and metabolic disorders in our body thus causing serious health problems. Obesity is a very common, severe, and costly disease. In United States, obesity prevalence was 42% in 2017 – 2018 and the number is 30% in 1999-2000. This disease always happens with other severe diseases such as heart disease, stroke, and certain types of cancer, leading to huge medical costs to people and government. So, more attention should be paid to the fat contents in food. The meaning of total fat is total lipids, including phospholipids(Holm and Wretlind 1976).

The commonly used techniques are Soxhlet analysis and acid/alkaline hydrolysis(Khoshtinat, Koohy-Kamaly et al. 2021). This method is based on an AOAC Official Methods of Analysis (AOAC). The first step of it is acid hydrolysis and sample drying, and then sequentially, the extraction itself on a Soxhlet device in which the whole process costs about couple of hours.

A new method relied on an innovative microwave-assisted extraction (MAE) approach makes the determination of total fat in cheese samples. MAE method is statistically equivalent to other methods, showing good performance and allows the determination of total fat in 12 samples simultaneously in 100 min, which shows a much faster and easier handling than Soxhlet(Adeel, Zuber et al. 2018).

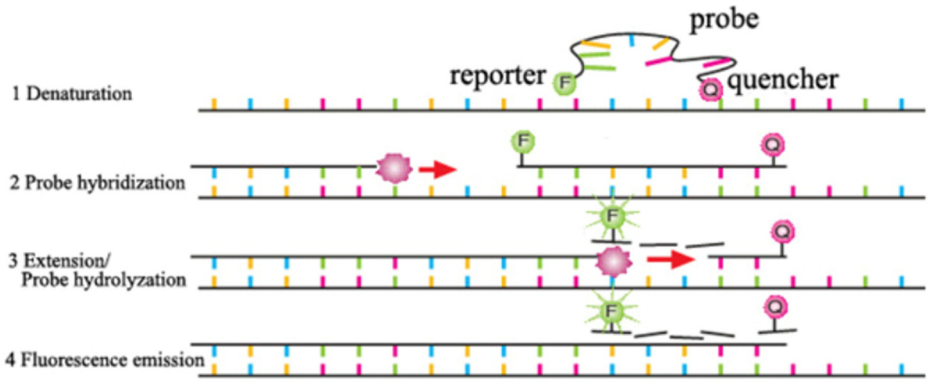

Figure 3: The steps of RT-PCR(graph from MyBioSource).

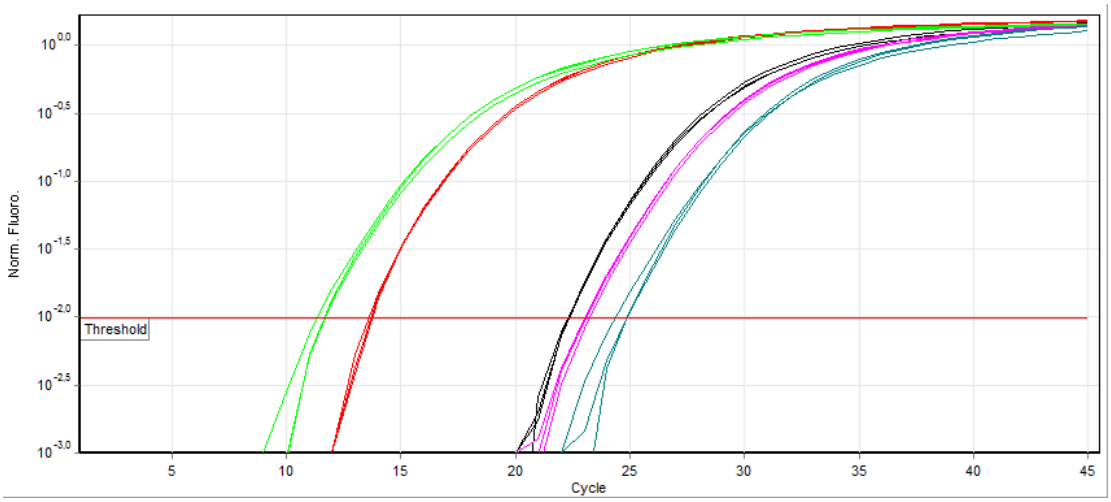

Figure 4: Typical results of RT-PCR(graph from Wikimedia).

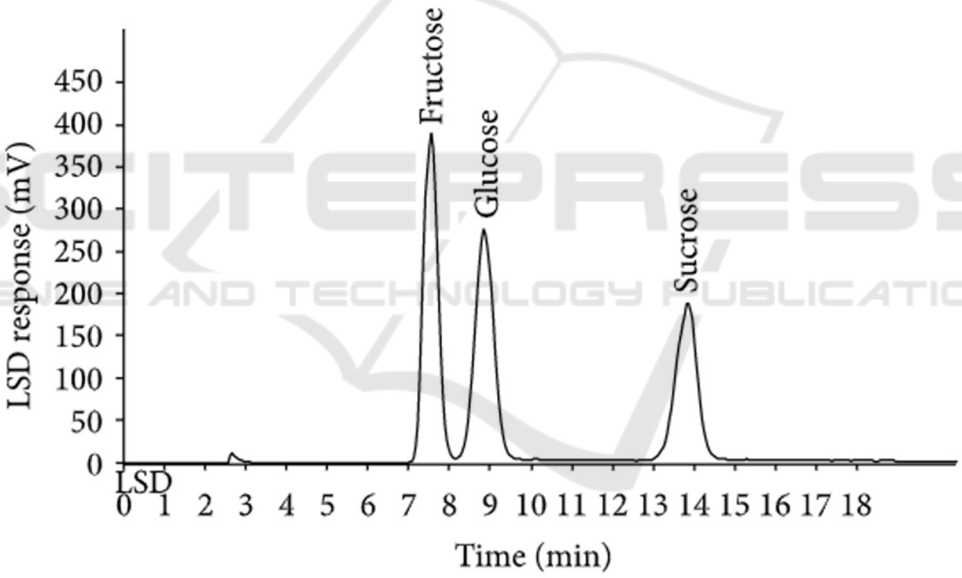

Figure 5: HPLC-ELSD profile of fructose, glucose, and sucrose standard compounds[14].

5 SUGAR DETECTION

Sugars are caloric and sweet tasting which occur ubiquitously in our life, including vegetables, honey, and fruits. Human beings are born with the preference for sweet taste. Lactose, a type of sugar naturally existing in milk, in breast milk ensures that this mainly source of nutrition for babies is palatable and acceptable. While in food most of the sugars are chemically added which are monosaccharide or disaccharide carbohydrates imparting sweet taste. Lot of foods contain some of each.

Sugars are ones of carbohydrate, and like other carbohydrates they also contain carbon, oxygen, and hydrogen molecules. Carbohydrates play an important role in a healthy diet, as do proteins, fats, and water. In addition to dietary fiber, in the condition that carbohydrates are consumed, they will be digested and broken down to glucose, serving as an energy source for most organs in whole body. Glucose is a better source of energy for blood

cells, the central nervous system, and the digestion system.

Fructose, glucose, and galactose are very common monosaccharides in which common disaccharides include sucrose, maltose, and lactose. Quantification of sugars are now determined by couple of methods. They include enzymatic method which measures sucrose phosphorylation and hydrolysis of fructose and glucose(Finney, Danehower et al. 2005) or measuring absorbance growth based on commercial standard assay of sugar kit(Hurtta, Pitkanen et al. 2004). In addition to mentioned above, High Performance Liquid Chromatography (HPLC) approach coupled with refractive index detector (RID) or evaporative light scattering detector (ELSD) are used as well. HPLC-ELSD shows many advantages especially for its compatibility, stability, and sensitivity with gradient elution when compared to HPLC-RID. Recently, developments in gas chromatography-mass spectrometry (GC-MS) equipment and techniques have made this technique becoming helpful in compositional and structural analysis of oligomers, polymers and monosaccharides, especially in food industry and life sciences areas.

6 CONCLUSIONS

Protein, fat and sugar are the main nutrients in food, which provide the energy supply to human body. With the development of technique, many detection approaches were well established for the past couple of years, all of this ensure the food safety and make the food components clear to customers which can help them know clear about the food components and have the authority to decide to have them or not.

In recent years, food testing and analysis technology has developed rapidly, but due to the limitations of sample pre-processing technology or the defects of the instrument method itself, many testing technologies are only at the qualitative or semi-quantitative level, and the accuracy of the results needs to be further improved. For example, continuously improve the detection equipment, increase the sensitivity and accuracy of the detection equipment, and optimize the pre-processing methods, so that the detection results reach an accurate level. At the same time, actively research and discuss various advanced detection methods and technologies according to the continuously developing food types and develop rapid analysis technologies that can simultaneously achieve high-efficiency sample pre-processing and sensitive follow-up detection to meet the urgent needs of today's food analysis.

In addition to the technique this regard, industry and the authority should also pay more attention to the laws in this area so that lot of illegal events can be avoided. Also customers should also learn more in order to be able to identify the food label in a good view.

So for a long time, total nitrogen content was used to the determine the protein content of foods in which Kjeldahl invented a method that has been used broadly to determine the total nitrogen content. But the method still costs a relative long time, researchers mainly focused on the time costa to improve the process to make it more efficiently. Recently, a developed method based on an automated instrumental technique was applied in food protein contents detection since it is capable of measuring the food protein concentration in a shorter time than Kjeladahl methods(Stitcher, Jolliff et al. 1969, Wiles, Gray et al. 1998). Even though the technique was developed recently, the technique is based on Dumas's method which was created over a century ago. It is already on its way to compete with the Kjeldahl method since it costs a shorter time without the loss of accuracy.

REFERENCES

Adeel, S., et al. (2018). "Microwave-assisted extraction and dyeing of chemical and bio-mordanted cotton fabric using harmal seeds as a source of natural dye." Environ Sci Pollut Res Int **25**(11): 11100-11110.

Finney, M. M., et al. (2005). "Gas chromatographic method for the analysis of allelopathic natural products in rye (Secale cereale L.)." J Chromatogr A **1066**(1-2): 249-253.

Holm, I. and A. Wretlind (1976). "Methods for complete intravenous nutrition with fat." Acta Chir Scand Suppl **466**: 62-63.

Hurtta, M., et al. (2004). "Melting behaviour of D-sucrose, D-glucose and D-fructose." Carbohydr Res **339**(13): 2267-2273.

Khoshtinat, K., et al. (2021). "Comparative study of salt, total fat and sugar contents of mayonnaise and salad dressings from the Iranian market." East Mediterr Health J **27**(5): 452-458.

Kubista, M., et al. (2006). "The real-time polymerase chain reaction." Mol Aspects Med **27**(2-3): 95-125.

Lin-Moshier, Y. and J. S. Marchant (2013). "A rapid Western blotting protocol for the Xenopus oocyte." Cold Spring Harb Protoc **2013**(3).

Rychlik, W. (1993). "Selection of primers for polymerase chain reaction." Methods Mol Biol **15**: 31-40.

Stitcher, J. E., et al. (1969). "Comparison of Dumas and Kjeldahl methods for determination of nitrogen in feces." Clin Chem **15**(3): 248-254.

Taylor, S. C. and A. Posch (2014). "The design of a quantitative western blot experiment." Biomed Res Int **2014**: 361590.

White, T. J., et al. (1989). "The polymerase chain reaction." Trends Genet **5**(6): 185-189.

Wiles, P. G., et al. (1998). "Routine analysis of proteins by Kjeldahl and Dumas methods: review and interlaboratory study using dairy products." J AOAC Int **81**(3): 620-632.