Analysis of the Application of High Performance Liquid Chromatography

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Abstract. With the continuous improvement of detection accuracy and precision requirements, the rapid development of modern detection technology, high-performance liquid chromatography with its high separation efficiency, high selectivity, high detection sensitivity, high accuracy of the advantages of a wide range of applications in many fields, is a qualitative and quantitative analysis technology. In this paper, the application of high performance liquid chromatography in food inspection, drug inspection and environmental monitoring is comprehensively described.

Keywords: High performance liquid chromatography, food testing, drug testing, environmental monitoring, application.

1. Introduction
High performance liquid chromatography, referred to as HPLC, is a chromatography method developed on the basis of classical liquid chromatography. It has the advantages of high sensitivity, high accuracy, high separation rate and wide application range, especially for the detection of high boiling point and volatile compounds, which highlights its advantages. Therefore, it has been widely used in food testing, drug testing, environmental monitoring and so on.

2. Application of high performance liquid chromatography in food detection
On the basis of the improvement of material life, people pay more attention to the quality of life. The food problem has become the focus of people's attention in today's society. Therefore, the analysis of food ingredients has become a hot topic of people's attention.

2.1. Nutrition testing

2.1.1. Amino acid detection. With the improvement of people's quality of life, people get the nutrition in food and pay more attention to the nutrition index of food. Amino acids are mainly decomposition products of proteins and enzymes, and there are 8 kinds of essential amino acids in the human body. Many conditions will cause their denaturation, so the detection of amino acids is more difficult, but the high performance liquid chromatography technology to solve this problem, using external standard
method of qualitative, internal standard method of quantitative, to achieve high precision detection of amino acids.

2.1.2. Sugar detection. Saccharides mainly include glucose, maltose, starch and so on. Due to the solubility and reducibility of sugar, the traditional detection methods can not be used for detection, but can use high performance liquid chromatography technology for detection. First, protein and other components in the sample were removed, and the chromatogram of various types of sugar in the sample was obtained by chromatograph. After parameter analysis, the content of various sugars in the sample was obtained. In view of the high sensitivity and high separation rate of high performance liquid chromatography technology, sugar substances can be quickly and effectively detected.

2.1.3. Vitamin test. Known as the "life-sustaining elements", vitamins play a vital role in the maintenance of human function and health [1]. In the past, vitamin detection is first separated and purified and then detected, which will change the vitamin structure and affect the detection results. With the wide application of high performance liquid chromatography, its detection advantages are prominent, strong anti-interference ability, can not only improve the detection speed, but also improve the accuracy, effective detection of vitamins.

2.2. Food additive testing

Food additive is a synthetic or natural substance added to food for the purpose of improving the quality of food such as color, aroma and taste, as well as for the need of preservation and processing technology. Generally speaking, most of the chemically synthesized food additives have certain toxicity, and only when they reach a certain concentration or dose level, the toxic effect will appear, so the amount of use should be strictly controlled. However, in daily life, the abuse of food additives has become a very serious problem in order to pursue the interests of products by illegal merchants.

2.2.1. Sweetener detection. Sweeteners are mainly used to increase the taste and taste of food. They exist in the form of adjuvant in food, including natural and synthetic. In general, sweeteners do not cause harm to the human body, but if used in excess, they can be harmful to health, leading to diabetes, obesity and other physical diseases. Therefore, in food safety testing, to strictly detect its content. With the help of high performance liquid chromatography (HPLC), the content of sweeteners such as alabasame, cyclate and acesulfide in food can be accurately determined. The recoveries are 97.9%-107.5% and the errors are 3.7%-4.4%, which can effectively improve the detection efficiency [2].

2.2.2. Preservative detection. Preservatives mainly prevent food bacteria from spoilage and prolong the storage time, including calcium propionate, potassium sorbate and sodium benzoate, etc., which are all artificially processed products, and excessive amount will harm health and increase the probability of cancer. Therefore, it is important to strictly monitor their usage. The traditional detection methods can not completely detect the preservatives, the use of high performance liquid chromatography technology can accurately detect the dosage of preservatives, through the comparison of the standard curve of preservatives and the curve to be measured, to know whether the preservatives in the sample exceed the standard problem, to ensure food safety.

2.2.3. Detection of pigment additives. Color additives are mainly used to improve the color and beauty of fruit juice, carbonated drinks and pastries, which can be divided into two kinds: natural color and synthetic color [3]. Natural pigment extracted from animals and plants, will not affect human health, but the cost is higher, therefore, synthetic pigment additives are widely used, once exceeded, will cause food poisoning, resulting in children's growth retardation. With the wide application of high performance liquid chromatography (HPLC) technology, it is possible to detect whether the pigment additive in food exceeds the standard by extracting the synthetic pigment from the sample. In addition,
this method can simultaneously detect various pigments of different types in food, which can not only improve the accuracy, but also improve the detection efficiency.

2.3. Detection of toxic substances

2.3.1. Detection of food processing hazards. Fumigation sauce food in the production process of the use of a large number of nitrite, its chemical reaction will produce N-nitrosamine, N-nitrosamine is a strong carcinogen, serious harm to health. Barbecue foods produce polycyclic aromatic hydrocarbons (PAHs) during processing, many of which have carcinogenic effects. In the past, the detection method is not only time-consuming, the results are not accurate, the use of high performance liquid chromatography in a short period of time, and can accurately detect the content.

2.3.2. Melamine detection in dairy products. The incident of melamine added to Sanlu milk powder has caused serious injuries to many children and damaged the urinary and reproductive systems. This incident has aroused widespread concern in the society and also become the focus of dairy products testing. Melamine is a nitrogen-containing heterocyclic organic compound, industrial raw material, because of its high nitrogen content is used by illegal businesses, added to dairy products, to increase the protein content of dairy products. Compared with gas chromatography, capillary electrophoresis and near infrared spectroscopy, high performance liquid chromatography has higher detection accuracy and smaller error. Under suitable test conditions, the detection limit of melamine was 0.005μg/mL, the relative standard deviation was 4%, and the linear range was 0.01~8.00μg/mL [4].

2.3.3. Aromatic amine detection. Aromatic amine is a kind of artificial synthetic pigment, which will harm the body when it gets into the body. If it is used too much, it will cause cancer. Therefore, it is not allowed to be added into the food, so special attention should be paid to the detection. High performance liquid chromatography can be used to determine whether the product contains aromatic amine pigment. This detection method is not only efficient, shortening the detection time, but also can ensure the accuracy of detection results.

2.3.4. Aflatoxin test. Aflatoxin is a strong carcinogen produced in corn, peanuts and other grain foods when mildew occurs, which can induce liver cancer if ingested by accident. Using high performance liquid chromatography, the selection of SIL6-X-1 column can quickly and accurately detect the content of aflatoxin in food, only 7 minutes to complete the detection [5].

2.4. Drug residue detection

At present, pesticides and veterinary drugs are widely used and varied, so it is necessary to adopt effective and reasonable means to detect drug residues in food safety.

2.4.1. Pesticide residue detection. The use of a large number of pesticide preparation in agriculture improves the yield of crops, but it also brings about a lot of pesticide residue problems. Pesticide residues include pesticide bodies and their metabolites, such as germicides, carboxates, organophosphorus pesticides, organochlorine pesticides, etc. Most pesticide preparations are toxic. Although pesticide residues in food are trace, they enter the food chain and slowly accumulate in the human body, posing a serious threat to human health. Therefore, before crops enter the market, it is necessary to carry out effective detection of pesticide residues in crops, and resolutely prevent crops exceeding pesticide residues from entering the market. Due to pesticide residues trace, heated easy degradation or deactivation, so need to adopt efficient, accurate and convenient detection method for testing, high performance liquid chromatography (HPLC) method is more practical in many detection methods of detection method, use were separated by high performance liquid chromatograph, through understanding of different pesticide residues chromatogram peak area curve, compare the food safety standards, to ensure food safety. High performance liquid chromatography (HPLC) has the advantages
of high sensitivity and high detection efficiency, and can carry out large quantities of detection in a short time. Therefore, this detection technology has also become a key technology in pesticide detection and analysis [6].

2.4.2. Veterinary drug residue detection. Livestock, poultry and fish are injected or fed antibiotics, antimicrobial, anti-parasitic and growth hormone drugs to improve the animal's resistance to disease and shorten its growth cycle [7]. However, drug abuse can lead to drug residues in animals, mainly penicillin, tetracycline, antibiotic sulfonamides and quinolones. These drugs enter the human body through the food chain, affect the digestion and immune system of the human body, and even cause cancer. In the national food safety standard GB31650-2019, the maximum residue limit of 104 kinds (class) of veterinary drugs such as albendazole in animal food and 9 kinds of veterinary drugs such as chlorpromazine should not be detected in animal food are stipulated [8]. Our country attaches great importance to the problem of veterinary drug residues. At present, there are a variety of detection methods, but high performance liquid chromatography is widely used because of its high efficiency, strong performance, and can be used for multi-drug detection and other advantages.

3. Application of high performance liquid chromatography in drug inspection

3.1. Testing of active ingredients
The testing of active ingredients of drugs is directly related to the quality and safety of drugs. Only after the active ingredients meet the standards can they be marketed. Using high performance liquid chromatography technology, can accurately determine the composition of the drug, not only easy to operate, but also high sensitivity and accuracy, to avoid the interference of additional agents in the drug detection results. For example, the test of flavonoids in Fengwei tea; The composition of Astragalus from different regions and different maturity was tested to screen Astragalus with good drug effect. This method was adopted to test the content of active ingredients in different regions, compare the efficacy of drugs in different stages, and select the areas with the best drug quality, which provided a guarantee for the quality of drugs.

3.2. Testing of drug component content and impurity content
Drug quality standards are formulated by the drug quality inspection department. When the content of active ingredients of drugs is tested, the content of harmful substances should also be tested to determine whether they belong to prohibited substances [9]. During the preparation, transportation, storage and use of drugs, due to changes in ambient temperature and humidity, some harmful substances may be produced. For example, during the preparation of drugs, intermediates, by-products and isomers may be brought in. In the process of medicine bottle transportation, it is easy to form degradables and polymers. The content of these substances is extremely small, and the accuracy of the detection results using conventional detection methods is very low. The high performance liquid chromatography (HPLC) technology can accurately detect the content of impurities, components and intermediates in the original drugs, with short detection time, high accuracy and high sensitivity. For example, in the process of preparation and use of terazosin hydrochloride tablets, the detection accuracy of thin layer chromatography is only 0.025mg/mL, while the detection accuracy of high performance liquid chromatography can reach 0.05μg/mL [10]. Therefore, the application of high performance liquid chromatography in quality control plays an extremely important role in avoiding the circulation of fake and shoddy drugs, improving the quality and safety of drugs and ensuring people's health.

3.3. Antibiotic drug testing
Due to the characteristics of antibiotic drugs, it is easy to cause adverse reactions in patients during clinical use. The inducing factors include impurities such as polymers, intermediates and degradation products. If the drug reaction is too strong, it will seriously threaten the life safety of patients. In order
to reduce or eliminate the adverse reactions caused by the use of antibiotics, it is necessary to carry out effective analysis of drug composition and control the amount of each impurity in antibiotics within the prescribed standard range. High performance liquid chromatography technology can separate the degradation products and other impurities in the raw materials in a short time, effectively control them, ensure the effect of drug action, reduce the occurrence of adverse reactions.

3.4. Chinese medicine composition test
With the development of traditional Chinese medicine industry, more and more traditional Chinese medicine products have come into our life. Traditional Chinese medicine is widely used because of its advantages of less toxic and side effects. Therefore, it is particularly important to control the quality of traditional Chinese medicine, and it is necessary to test its components. The composition of traditional Chinese medicine is complex, containing a variety of trace elements and organic components. Conventional testing methods are difficult to guarantee the accuracy of the test results, and the testing is very difficult. The wide application of high performance liquid chromatography (HPLC) technique, replaced by thin layer chromatography (TLC), decrease the difficulty of the Chinese traditional medicine separation in a short period of time can drug in traditional Chinese medicine (TCM) to be detected and the separation of impurities, can the Chinese native medicine ingredient, content and more accurate detection, identification, and ensure quality of traditional Chinese medicine, so the high performance liquid chromatography (HPLC) technology is seen as a method to detect the main Chinese medicine effective component content. For example, this method was used to determine the content of baicalin and cryptotanshinone in Dancen dropping pills, and the accurate quantitative results and separation degree could be obtained. Therefore, in the process of testing the ingredients of traditional Chinese medicine, the application of high performance liquid chromatography technology can control the effective ingredients of traditional Chinese medicine quantitatively, and promote the standardization and modernization of the quality inspection of traditional Chinese medicine while improving the inspection efficiency and quality.

3.5. Drug identification
High performance liquid chromatography technology provides new ideas and methods for drug differential diagnosis. The discovery of new drugs is accompanied by many unknown factors, so it is necessary to accurately identify the drugs. The properties, retention time and composition characteristics of the drugs should be recorded as the qualitative parameters of the new drugs [11]. To distinguish the difference of medicinal value of different drugs, so that drugs can better play their role. For example, when identifying Schisandra chinensis, it can quickly and effectively identify the component content in Schisandra chinensis. Research on new chiral drugs, metabolism and quality control of chiral drugs; To test the non-chemical components of drugs, effectively identify the non-chemical components added in health care products and Chinese patent medicines, to ensure the quality of drugs. High performance liquid chromatography technology has high analytical ability and separation function, can be a short time quantitative inspection, separation of qualitative pharmaceutical components, so as to ensure good drug effect [12].

4. Application of high performance liquid chromatography in environmental monitoring
Environmental pollution is a serious problem facing mankind at present. It can be divided into air pollution, water pollution, soil pollution and so on, which brings serious harm to human health and ecological environment. Therefore, it is of great significance to monitor the environment.

4.1. Atmospheric environment monitoring
Atmospheric environmental monitoring is the determination of pollutants in the atmosphere and its concentration, observation, analysis of its changes and the environmental impact of the determination process. The pollutants monitored mainly include sulfur oxides, nitrogen oxides, carbon monoxide, ozone, halogenated hydrocarbons, hydrocarbons, dust fall, total suspended particulates, drifting dust
and acid deposition. High performance liquid chromatography (HPLC) stands out among many monitoring methods because of its high separation efficiency, high selectivity and high detection sensitivity. At present, researchers have used high performance liquid chromatography technology to determine the content of formaldehyde, acetaldehyde, aldehyde ketone pollutants, methylsulfonon, polycyclic aromatic hydrocarbons and other pollutants in the air, low detection limit, high recovery rate, and can realize the simultaneous analysis and determination of a variety of similar pollutants, both qualitative and quantitative.

4.2. Water environment monitoring

High performance liquid chromatography (HPLC) has been widely used in water environment monitoring. Traditional pollutant monitoring, including nutrient elements and special elements, can accurately and efficiently detect and distinguish the type, content and pollution of pollutants in water, providing a strong guarantee for future water quality analysis. Inorganic anion and anion analysis, which is an important work of drinking water quality detection, detection of cations are Na\(^+\), NH\(_4\)\(^+\), K\(^+\), Mg\(^{2+}\) and Ca\(^{2+}\). The anion has Cl\(^-\), NO\(_2^-\), NO\(_3^-\), Br\(^-\), PO\(_4^{3-}\) and SO\(_4^{2-}\)\[13\]. Using this method, the detection limit is reduced, the detection time is shortened, the detection efficiency is improved, the separation effect is obvious, and large quantities of detection and analysis can be realized. Water organic monitoring, accurate detection of organic content and pollution, including N-methylcarbamate insecticides, glyphosate, polycyclic aromatic hydrocarbons, benzidine compounds, carbamate drugs, etc. Different valence state of heavy metals analysis, high performance liquid chromatography (HPLC) technique can not only to test the different pollutant, can also be of the same element in different valence precision testing, to detect the contents of different valence state elements of concrete, in order to accurately analyze the water contain pollutant category and the polluting extent, such as trivalent chromium and hexavalent chromium, trivalent arsenic and pentavalent arsenic \[14\].

4.3. Soil environmental monitoring

Soil environmental monitoring is to determine the degree of environmental pollution and its changing trend by measuring the representative values of factors affecting soil environmental quality. High performance liquid chromatography (HPLC) is mainly used in soil environmental monitoring for pesticide residue monitoring and arsenic speciation analysis \[15\]. Now researchers have measured the residual soil of atrazine and its main metabolites to take off the ethyl atrazine, isopropyl atrazine and 2-hydroxy atrazine, pahs pollutants, atrazine pesticide residues, isopropyl lung and isopropyl aniline, five fluoride sulfonic grass amine, cefuroxime amine, such as a variety of pesticide residues in soil, insect and arsenite, dimethyl arsenic and arsenic and arsenic acid salt and so on four kind of form, implements the analysis of different valence state arsenic determination. High performance liquid chromatography is sensitive, accurate and precise, with low detection limit and high recovery rate.

5. Conclusions

With the development of modern information technology, high performance liquid chromatography has been widely used. High performance liquid chromatography (HPLC), with its advantages of high sensitivity, high efficiency, high precision and high resolution, has played an important role in food detection, drug inspection and environmental monitoring. With the continuous improvement of detection breadth and accuracy, the combination of high performance liquid chromatography (HPLC) with evaporative light detector and mass spectrometer not only broadens the detection range, but also achieves efficient separation of complex organic mixtures through the powerful component identification ability of mass spectrometer. With the continuous expansion of the application of high performance liquid chromatography technology, it will promote the development of China's industry, agriculture, medicine, food, environment and other fields.
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