Overview of the principle of detecting whitening components by high performance liquid chromatography

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Abstract. With the scientific development of chemical technology and life technology, more and more substances have been discovered and applied to current human production and life. In the process of substance analysis and identification, effective detection tools are needed to accurately identify substances. As a rapidly developing and efficient detection method, HPLC has been widely used in the detection of various cosmetic substances, including nicotinamide, firstly introduces the development background of HPLC, the importance of skin whitening in today's society, and some common whitening ingredients and principles. The application of HPLC in the determination of niacinamide, 3-o-ethyl ascorbic acid and α-arbutin is introduced in the following, and the detection principle and advantages and disadvantages of using HPLC for detection are analyzed. Finally, we analyze and summarize the factors that affect HPLC detection. This approach can be used for market research and quality control of functional cosmetics.

Keywords: high performance liquid chromatography, HPLC, skin-whitening, nicotinamide, 3-O-ethyl ascorbic acid, alpha-arbutin.

1. Introduction

1.1. Background of High-Performance Liquid Chromatography

The idea of chromatography and chromatography was first proposed in 1903 by the chemist Tswett of Russian factories. Thwaites used tomography to depict his colour experiments. Paper chromatography, ion-exchange chromatography, thin-layer chromatography, and other liquid chromatography techniques appeared after 1930. A relatively comprehensive set of theories and methods for gas-liquid chromatography was proposed by British researchers Martin and Synge in 1952 on the basis of earlier chromatographic work, which made a great advance in gas chromatography technology and contributed to the rapid development of gas chromatography over the course of the following decade [1]. In 1958, building on the work of Moore and Stein, ion-exchange chromatography instrumentation gave rise to the amino acid analyzer, a major attempt at modern liquid chromatography, but the efficiency of separation was still not ideal. By the end of the 1960s, with the development of theory and practice in gas chromatography, as well as advances in mechanical, optical, electronic, and other technologies, liquid chromatography was once again active. Liquid chromatography using high pressure pumps and chemically bound stationary phases led to the advent of high-performance liquid chromatography (HPLC) in the late 1960s [2]. After the middle 1970s, microprocessor technology was used in liquid chromatography, which further improved the level of automation and the analytical precision of the instruments. The rapid development of biological engineering and life sciences at home and abroad after 1990 brought more and more new problems to the split, purification and preparation of high-performance liquid chromatography technology such as the human genome project and HPLC for pre-separation proteomics. HPLC Schematic diagram is shown in figure 1.

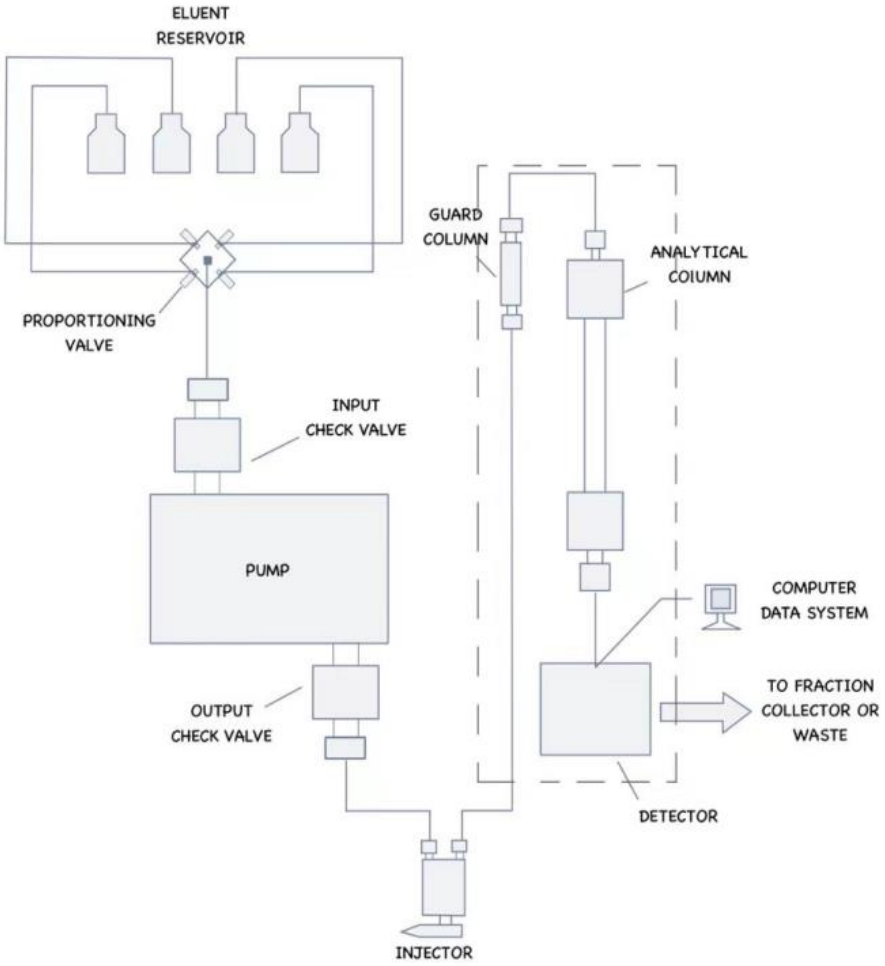

Figure 1. Schematic diagram of high-performance liquid

1.2. Background of Skin-whitening

Having normal, fair skin is one of the top beauty concerns for most Asian women. "China Beauty industry Market Research Report" shows that 50% of women are concerned about skin whitening [2]. In the 21st century, people are becoming more aware of skin care. It's not just women, men are starting to pay attention to skin care. Increasingly, people want to lighten their skin for a fairer complexion, and whitening cosmetics are favored by Asian consumers, especially in China. The love and pursuit of fair skin dates back to ancient times, when a "handsome man" was described as someone with fair skin. Others see whiteness as a symbol of purity and superiority and an example of class distinction.

When your skin lightens, you feel confident. Fair skin gives many modern women confidences. Research has shown that 70% of Asian women now face skin lightening, but this is even greater on the African continent. Lighting up their skin will boost their confidence. Not everyone is so confident. People need to look for different things to boost their confidence, thus nowadays women tend to make their skin lighter and brighter simply to fit in and have confidence [1].

1.3. Common Skin-whitening Ingredients and Skin-whitening Principles

Whitening has become a daily skin care step, most skin care brands have whitening products, and most of the whitening products are hotly sought after by consumers.

People will choose the skin care products that can achieve the whitening effect in daily use. According to the investigation, the most commonly used whitening ingredients include Mulberry extract, Alpha hydroxy acids (particularly glycolic acid and lactic acid), Vitamin C and nicotinamide. The research and development of whitening skin care products mostly uses chemical means to further

process the existing whitening ingredients, such as looking for derivatives of some ingredients, or some small molecular ingredients [3].

The mechanism of action of whitening agent has five aspects: (1) inhibit the formation of melanin particles (inhibit tyrosinase activity, inhibit dopamine pigment isomerase activity, inhibit oxidation reaction); (2) Inhibit the transfer of melanin granules to keratinocytes; (3) Accelerate the transfer of melanin from keratinocytes to cuticle and promote cuticle shedding; (4) Blocking signal transduction pathways during melanin production (endothelin antagonist, inhibition of α-melanotropin (α-MSH) adrenocortical hormone (ACTH) binding to melanocyte melanocortin receptor 1 (MC1R)); (5) Reduce the negative effects of exogenous factors such as ultraviolet light on the formation of melanin [4].

2. HPLC Applied in the Detection of Skin-whitening Ingredients

2.1. HPLC Applied in the Detection of Nicotinamide, 3-O-ethyl Ascorbic Acid and α-arbutin

2.1.1. HPLC Applied in the Detection of Nicotinamide

Nicotinamide, also known as niacinamide (NAA), is a virtually colorless and odorless vitamin B3, vitamin PP, white crystalline powder, or crystal powder, which is soluble in water, ethanol, ether, and chloroform, and is sparingly soluble in water [5]. Nicotinamide is a potent and well-tolerated antioxidant that has been reported to inhibit the transfer of melanocytes from melanocytes to keratinocytes resulting in the reduction of melanin in the skin. Nicotinamide is therefore used in cosmetic whitening. However, it has also been reported by Bissett et al. (2004) and Kawada et al. (2008) that topical treatment with nicotinamide and cosmetic products that contain nicotinamide have been shown to have anti-wrinkling effects [6], and it has been suggested that this treatment may be effective in reducing the incidence of caries.

For example, the determination of nicotinamide in cosmetics using high-performance liquid chromatography and capillary elution techniques has the potential to accurately determine concentrations in various formulations without the need for extensive analysis. nicotinamide as a natural product or chromatography by extract.micelle electrophoresis with field-amplified injection has been previously reported. Nicotinamide is a water soluble compound (hydrophilic) . A number of techniques have been developed for the determination of nicotinamide in biologic samples, including gas chromatography and HPLC-based methods using UV or mass-detection chromatography. Because of its special properties, a variety of detection methods such as gas chromatography and ultraviolet HPLC can now be used [6].

Research finding that study was to determine the concentration of niacinamide in human blood serum obtained by reverse phase HPLC or surface enhanced Raman scattering. The method was carried.

2.1.2. HPLC Applied in the Detection of 3-O-ethyl Ascorbic Acid

3-O-ethyl ascorbic acid, as a stable derivative of VC that can be prepared easily. These structural changes increase the stability of the molecule and enhance its transport across the skin, to overcome the problem of easily decomposing pure vitamin C. 3-O-ethyl ascorbic acid inhibited the activity of the protein, thereby reducing skin darkening more effectively as a consequence of exposure to UV radiation [6].

HPLC analysis provides a rapid response time and low sample preparation costs. The analytical performance is also very good in comparison with standard chromatographic techniques. This method can be used in conjunction with other methods such as GC or LC coupled with mass spectrometry in order to achieve accurate data. However, its safety and suitability for clinical application has yet to be proven. The objective of this study was to develop a new 3-O-ethyl Ascorbic Acid Spectroscopy Method using a novel type of ion-exchange resin, which is known as "Nano-Coulter", for the detection of it.

2.1.3. Application of HPLC in the Detection of α-arbutin

Arbutin is a natural bleaching agent and has been observed in a variety of plant families such as magnolia, cranberry, blueberry, as well as several varieties of pear. Arbutin has been shown to effectively reduce the production of melanin via tyrosinase inhibition. α-arbutin has been tested in cultured melanoma cells as well as in human skin models for inhibition of the biosynthesis of melanin, have shown that α-arbutin effectively inhibits the synthesis of melanin without any cytotoxicity. α-arbutin has been shown to inhibit tyrosinase in murine melanoma ten times more potently than β-arbutin. α-arbutin can effectively inhibit melanin synthesis, and it is effective and safe in the treatment of pigmentation disorder [7]. In addition, there have been many reports and studies demonstrating that alpha-arbutin can be determined by HPLC, and experimental results have shown it to be particularly efficacious. This invention is concerned with a method to detect and quantify the presence of an organic compound in aqueous solution. One aspect of the invention is that the method includes: providing.

2.2. Analyze HPLC

2.2.1. Principles of HPLC

HPLC can make use of different properties of substances to effectively separate substances in the process of contact between the mobile phase and the fixed phase, and run the substances containing to be measured and the mobile phase under pressure and carry out the column process. Different substances can reach different peak times due to their different physical and chemical properties, and finally achieve effective identification. A low-pass (detector) device is used to measure the separation of these components at the output (column) of the tube. The output of this detector is called the "HPLC method. Although the performance of the LC and HPLC methods is similar in principle, its speed, efficiency, sensitivity and ease of operation are all significantly superior to other methods. While HPLC retains primary credit for analysis, it is still possible to prepare at an early stage with simple liquid chromatography [8]. However, using simple techniques such as HPLC would require additional preparatory steps and may lead to more expensive sample analysis than other methods. This also proves the use.

2.2.2. Pros and Cons of High-Performance Liquid Chromatography

Swift and effective separation (extreme resolution power). 2. Continuous monitoring of the column flow. 3. It can be used to separate and analyze particularly complex mixtures. 4. Precise quantitative measurements. 5. The same column can be used for both reproducibility and reproducibility analysis. 6. Adsorption, distribution, ion exchange, and repulsive column separation are excellent. 7. The HPLC method is in some ways more versatile than the GLC method because it has the advantage that it is not limited to volatile and thermally stable solutes, and the HPLC method has a wider selection of mobile and stationary phases. 8. Aqueous and non-aqueous samples can be analyzed with limited or no sample preparation. 9. A wide range of solvents and column fillers are available, providing a strong degree of selectivity for specific analyses.

Column performance is particularly sensitive, depending on the binning method. 2. Moreover, no universal and sensitive detection system is available. 3. High power consumption, low sensitivity to certain compounds, and some compounds are irreversibly adsorbed and undetectable (Ali, 2022).

3. Discussion

High performance liquid chromatographs play an important role in the detection of chemical substances. Factors that affect HPLC's results, include:

a. Internal diameter: The internal diameter (ID) of the HPLC column is a critica l aspect that determines the amount of analysis that can be mounted on the colu mn and also has an e ect on the sensitivity.

b. Large column sizes are common in industrial applications, such as the purification fo r later use of pharmaceuticals. Low ID columns lead to improved sensitivity and less solvent consumption, but at the cost of a reduction in carrying capacity [9].

c. Particle size: Most conventional HPLC is carried out with a stationary phase attached to the exterior of miniature spherical particles of silica (particular ly short beads). Smaller particles would generally provide greater surface area and better separation, but the pressure required for optimal velocities to be linear increases as the reciprocal of the square of the particle diameter [10].

d. Aperture: The numerous stationary phases are porous to provide a greater surfa ce surface area. Tiny aperture s provide greater surface area, while larger aperture s have better dynamics, especially for larger analytes. The ability of the analyte molecule to penetrate the interi or the particle and to interact with its inner surface is governed by the size of the por e. This is particularly significant considering that the ratio of the outer grain area to the inner grain area is approximately 1 :1000. Interactions between surface molecules occur predominantly at the inner surface of the particle [11].

e. Pump press: Pumps vary in their ability to press, but their performance is measured by their ability to produce rat es that are low, consistent and repeatable. Modern HPLC systems have been modified to work at higher pressures and are thus capable of using smaller particle sizes within the column [12]

f. Temperature: For proper HPLC operation, temperature has its own unique effects. Most HPLC columns are able to operate at or near room temperature (25-35◦C). But there are cases where higher temperature atures are required.

HPLC is a versatile and simple method for the simultaneous determination of arbutin, niacinamide, 3-O-ethyl ascorbic acid, as well as additional ingredients in functional cosmetic products. From different formulations, the validated method achieves linearity, accuracy, and perfect accuracy for all of the compounds tested. Virtually all of the active ingredients used in the commercial samples tested were found to be greater than 90% [13].

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