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Analysis and Biomedical Applications of Microfluidics in the Field of TCM

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Introduction

Traditional Chinese medicine (TCM), which is rich in cultural heritage and has characteristics of advocating and conforming to nature, has demonstrated its significant value to life and health. It is characterized by a singular theoretical system and research methods. For instance, TCM treatments have made incremental progress in the fight against the 2019 Corona Virus Disease (COVID-19). According to clinical observations and evidence, more than 90% of the confirmed cases in China have benefited from six TCM recipes that have been shown to be remarkably effective for treating COVID-19 patients. The use of cutting-edge scientific and technological advancements, particularly learning from interdisciplinary concepts like the integration of TCM and Western medicine, has made the modernization of TCM an inevitable trend on the basis of inheriting and developing advantages and characteristics. Pathogenic bacteria pose a serious threat to the safety of CHMs and can result in adverse reactions as well as chronic disease. Time-consuming operation and the absence of multiplex detection continue to be major drawbacks, despite the fact that culture-based methods—the current gold standard—are sufficiently sensitive. Bacteria were specifically labeled by their corresponding mass tags, which could be released and ionized after laser irradiation following aptamer binding, primer amplification, and DNA hybridization. Without microbial mass spectra databases, the analysis of mass tags could specifically detect multiple bacteria simultaneously. This strategy could be used to analyze pathogens in CHMs and has been used to successfully detect practical milk samples.

Screening and Pharmacological Activity Evaluation of CHMs

In the development of anti-tumor therapy, dynamic and high-throughput drug screening in large-scale cell spheroid arrays has long been anticipated. Liu and co. for high-throughput antitumor screening constructed a microfluidic platform with large multiparallel 3D tumor spheroids. The platform had six groups of pneumatic microstructure arrays, each with four units containing 28 P-Ss. When used in conjunction with the vascular network, the organ microfluidic chip can offer a different method for evaluating CHMs in animal experiments. The blinded screen can test a small library of compounds because each VMO can be addressed independently and has hydrostatic pressure-driven flow. . In order to create artificial structures in which cells and their microenvironment are precisely controlled, organ-on-chips technology uses our understanding of human organs. We developed a summary based on the application of microfluidic chip technology in TCM for the application of microfluidic chip technology in biomedicine and the urgent need for the modernization of TCM. Organoids, on the other hand, develop from self-organizing stem cells and follow intrinsic developmental programs. The quality analysis, delivery, and fabrication of nano CHMs, as well as the screening and pharmacological activity evaluation of CHMs for the prevention and treatment of major diseases, were all examined in depth in this article. With the help of microfluidic chip technology, CHM quality control can avoid variations between batches, monitor pesticide residues, and quickly separate components. Other benefits include low costs, high sensitivity, labor savings, and a small volume. For the study of complicated CHM components, a low-cost, fast, multi-target, microquantification analysis and detection system is in high demand. The study of TCM has increasingly relied on cutting-edge microfluidic technology. A microfluidic chip, also known as a "lab-on-a-chip," is a chip that is several square centimeters in size and incorporates fundamental operating units used in the chemical and biological fields, such as sample preparation, reaction, separation, detection, cell culture, sorting, and lysis. Microfluidics can be widely used in a variety of fields, including disease diagnosis and treatment, drug screening, CHM identification, forensic identification, food hygiene supervision, and environmental testing, thanks to its advantages of high resolution and sensitivity, low cost, short analysis time, and small footprint of analysis equipment. Microfluidics is anticipated to provide a technical support platform for the new design of biological macromolecules and drug development, rapid screening of compounds, and drug development, as well as new avenues for human understanding of the origin, inheritance, development, and evolution of life. Microfluidic chips will become increasingly important in medical research as studies examining the function of individual genes or signaling pathways at the tissue and organ level become essential.

Quantification of Marker Components for Authenticity and Chemical Fingerprinting

Natural plants are the source of CHMs, and the different chemical components of different species of plants tend to affect the quality of CHMs. Therefore, the foundation for their

clinical application is the identification of current CHMs. The description, microscopic observation, and physical and chemical properties, as well as their composition, are the primary focus of CHM identification. These methods of identification frequently necessitate skilled personnel and inefficient equipment. The efficacy of CHMs is greatly impacted by the different plant varieties' tendency to behave differently and to produce toxic substances. Currently, the character, microscopic observation, identification of physical and chemical properties, and composition identification of CHMs are the primary methods for their identification, and related testing is carried out by trained professionals. Additionally, it is more challenging to distinguish between powder and patent medicines. The development of herbal medicine is influenced by a variety of factors, including human factors, biological genetic factors, and environmental conditions, each of which will have its own distinct character. At the same time, discriminators' subjective experiences easily limit character identification, making it impossible to standardize the identification of CHMs with high plasticity, low stability, and repeatability. The growth site and the growth cycle are connected to the type and amount of secondary metabolites. Chemical testing is a common method for the identification and quality control of CHMs and plays an essential role in the quality control of chemical drugs. Quantification of marker components for authenticity and chemical fingerprinting for consistency between batches demonstrate the growing use of analytical techniques like High Performance Liquid Chromatography (HPLC), Gas Chromatography (GC), and Mass Spectrometry (MS) in the pursuit of comprehensive product control.