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Review

Recent Progress in Nanomaterial-Based Surface-Enhanced Raman Spectroscopy for Food Safety Detection

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Abstract: Food safety has recently become a widespread concern among consumers. Surface-enhanced Raman scattering (SERS) is a rapidly developing novel spectroscopic analysis technique with high sensitivity, an ability to provide molecular fingerprint spectra, and resistance to photobleaching, offering broad application prospects in rapid trace detection. With the interdisciplinary development of nanomaterials and biotechnology, the detection performance of SERS biosensors has improved significantly. This review describes the advantages of nanomaterial-based SERS detection technology and SERS's latest applications in the detection of biological and chemical contaminants, the identification of foodborne pathogens, the authentication and quality control of food, and the safety assessment of food packaging materials. Finally, the challenges and prospects of constructing and applying nanomaterial-based SERS sensing platforms in the field of food safety detection are discussed with the aim of early detection and ultimate control of foodborne diseases.

Keywords: SERS; biosensors; molecular fingerprint; foodborne pathogens; food packaging

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1. Introduction

1.1. The Necessity and Importance of Rapid Food Safety Detection Methods

Food safety is a critical aspect of safeguarding public health and ensuring consumer wellbeing, particularly in the context of the increasingly interconnected global food trade and supply chains. The growing recognition of chemical pollution, microbial contamination, and adulteration in food has emphasized the importance of implementing effective safety measures [1]. Consequently, rapid detection methods are paramount in this scenario. Often limited by their labor-intensive and time-consuming nature, traditional detection technologies cannot meet current demands. Hence, there is an urgent need to develop rapid, convenient, and accurate analytical and detection techniques. These innovative methods represent a future trend in food safety as they address the limitations of conventional approaches and enable timely interventions and effective risk management [2].

Rapid detection methods play a pivotal role in upholding food safety standards by enabling swift identification of biological and chemical contaminants in food. These methods encompass a range of techniques, including culture and colony counting, immunology-based methods, polymerase chain reaction, and serological approaches [3,4]. By providing rapid results, they can contribute to the prevention of outbreaks, curb the spread of contamination, and mitigate the economic impact on food producers, distributors, and retailers. Furthermore, rapid detection methods contribute to regulatory compliance, quality assurance, enhanced traceability, and advancements in detection technologies [5,6]. Their multifaceted benefits underline their significance in ensuring the safety and integrity of the global food supply. The significance of food safety cannot be overstated and the need for