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Review Article

Importance of food forensics and its mandatory implications in health safety and compliance

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ABSTRACT

Food forensics is crucial due to the risk of foodborne illnesses caused by bacteria, toxins, pesticides, and other pollutants. Traditional detection techniques like microscopy, nucleic acid analysis, and immunoassays are used, but array-based sensing approaches are gaining popularity due to their reliability and accuracy. Advances in multivariate analytical techniques and machine learning-based methodologies allow for rapid and reliable food testing. Food forensics have a significant role in detecting and identifying food pollutants, ensuring the safety of the global food supply. Adulteration, the intentional contamination of food with substandard or inexpensive chemicals, can lead to long-term poisoning, illnesses, and even deaths. Accreditation is essential for food forensics, which involves rigorous auditing by internationally registered bodies to ensure quality compliance. The study explored food forensics, a scientific procedure identifying authentic and counterfeit food items through chemical analysis. It highlighted the literature concerned about the risk of adulteration in locally sourced products and how mass spectrometry enhances reliability, information, and analysis compared to conventional methods.

1. Introduction

Food forensics is paramount because of the potential danger of foodborne illnesses caused by bacteria, toxins, pesticides, and other pollutants. Biogenic amines in processed food are the key indicator of freshness and deterioration. Traditional detection techniques such as microscopy, nucleic acid analysis, and immunoassays are commonly employed. However, array-based sensing approaches are gaining popularity due to their ability to provide reliable and precise analytical procedures. The progress in multivariate analysis techniques (MLR) and methodologies linked with machine learning (ML) allows for the rapid, reliable, and accurate identification of analytes employing sensor arrays. Commercial applications have transitioned to developing analytical methods that rely on arrays of electrical and chemical sensors.[1]

Food forensics uses scientific methods to authenticate and trace foodstuffs.[2–5] Forensic Chemistry employs chemical methodologies to assist investigative organizations and law enforcement. Food forensics is an academic discipline that examines explicitly and investigates any unlawful activities associated with food items or their use within a particular region. Further, adulteration refers to the intentional contamination of food with substandard or inexpensive, inedible, or poisonous chemicals, resulting in long-term poisoning, illnesses, and potentially even deaths. Food forensic investigations have gained little popularity, particularly in India, where the Food and Drug Administration (FDA) routinely conducts most cases. A study assessed if existing methods should have been modified to address vendors' criminal intentions and regulations regarding local commodities' presence in households throughout India.[6–10]

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Food forensics is a proven process that applies scientific techniques to detect and identify food pollutants, hence ensuring the safety of the worldwide food supply. The process entails utilizing analytical methods to verify the authenticity and traceability of food products. Food contamination can occur through chemicals, microorganisms, or foreign objects. Chemical contamination can occur either through direct exposure or indirect means, such as the presence of dangerous chemicals, pesticides, or additives. Indirect contamination arises because of the application of pesticides for crop protection. Biological contamination refers to the presence of microorganisms that result in alterations in sensory perception. Spoilage organisms that are the primary sources are observed in air, insects, water, dust, factory workers, employees, and stray animals.[1,11] Altogether, all these factors were critically discussed in this article.

2. Materials and Methods

In this article, the study extensively searched and reviewed relevant articles in the last ten years from open-access databases published globally by reputed publishers.

3. Discussion

A study revealed that locally available items are more vulnerable to adulteration, with two milk samples showing detergent, four tea leaves samples showing artificial color, two chili powder samples showing Sudan III, and a few sawdust. Ghee samples showed vanaspati and starch, pulses had unknown colors, honey had sugar and jaggery, and asafoetida samples showed dirt and impurities. The study recommends enforcing measures to check adulteration in these items, as they are more frequently purchased than expensive alternatives.[11,12] The global dietary cum herbal supplements market reached 140 billion US dollars in 2020, with India being a potential market. This study aims to assess safety concerns and understand consumers' and patients' consumption behaviors of these supplements. While some supplements have adverse effects in pregnancy and lactation, they can help with chronic health issues like skin and hair health, poor immunity, and undernutrition. The study emphasizes the importance of government policies and regulations, as India is the second population-based country globally.[13] Chemical contamination in food products can be direct or indirect, involving hazardous chemicals like pesticides, heavy metals, toxins, and fertilizers. Direct contamination involves replacing expensive products with low-cost alternatives, while indirect contamination occurs from pesticides used to protect crops. Only 0.1% of pesticides target organisms; unconsumed toxins can enter the environment. Food forensic analysis uses methods like Mass Chromatography and Surface Plasmon Resonance Spectroscopy.[14–17] Biological contamination involves microorganisms growing in zoonotic sources like sewage, water, and air, causing sensory modifications and metabolites. Spoilage organisms like Escherichia coli, Staphylococcus aureus, and Salmonella cause food poisoning outbreaks and human death.[18] Organisms transmitted between animals and humans, known as zoonotic organisms, can thrive in environments with low pH and high humidity. In such settings, these organisms can produce harmful substances called mycotoxins, which can cause damage to the central nervous system. Food allergies, which impact approximately 1-2% of adults and 5-8% of children in Western countries, also have a role in contamination.[19–22]

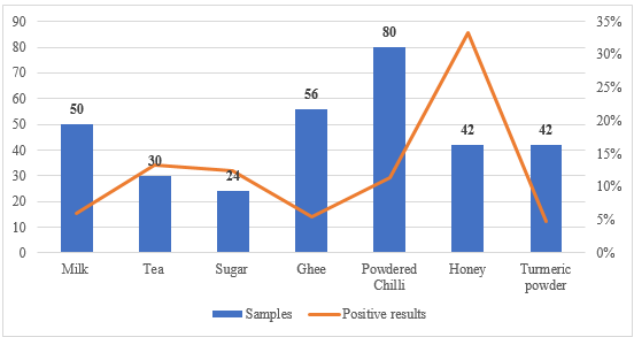

Figure 1: Sample-wise, Seven food items' positive results of adulterations[1,11]

It is necessary to have the proper accreditation of both government and private organizations to ensure quality compliance. The food industry in every country has strict rules and regulations, but still, there is a gap or negligence in quality assurance (QA) cum quality control (QC). Hence, accreditation is a value-added certification achieved through rigorous auditing by internationally registered bodies. It involves evaluating quality standards implemented by all departments or management, with skilled auditors performing the entire process. The process considers education, infrastructure, safety, security, department roles, and senior management and is crucial for private organizations. Accreditation can assess and certify food forensics periodically in every food manufacturer.[23] Food forensics involves verifying the authenticity of food products. Authentication is a procedure to check if a product has been adulterated or counterfeited, while traceability is a process to verify the link between a food and its raw materials. Authentication studies use chemical parameters to differentiate authentic products from non-authentic ones, while traceability studies use chemical parameters to track production stages. Authentication and traceability are not synonyms but work together to ensure food quality for consumers.[24]

4. Conclusions

Food forensics is a scientific procedure that examines the genuineness of food items by analyzing chemical factors to distinguish between authentic and counterfeit products. It aids in guaranteeing the quality of food for consumers. According to a study, locally sourced products are more prone to adulteration, as seen by detergents, artificial colors, and contaminants in specific samples. Mass spectrometry has substantially contributed to food forensics by providing a high level of reliability, comprehensive information, and rapid analysis compared to conventional methods.

5. Source of Funding

None.

6. Conflict of Interest

None.

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