

Review of methods for the analysis of culinary herbs and spices for authenticity

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Background

Herbs and spices are a commodity group that consistently appear in the top ten commodities most reported as being adulterated. Due to the large variety of products that fall within the category of herbs and spices, complex global supply chains and commercial production processes, methods for verifying their authenticity / detecting fraud are not straight forward.

The main aim of this project was to identify methods for the analysis of culinary herbs and spices, in their dehydrated or dried form, for authenticity with a focus on detecting deliberate adulteration.

Stakeholder engagement revealed that with respect to authenticity, herbs and spices of most concern are oregano followed by black pepper. Chilli powder, saffron, paprika, and turmeric. The main authenticity issues encountered are substitution, adulteration, and concealment. Unified strategies for the sampling of herbs and spices were not identified, with the type of sampling employed i.e., targeted, general screening, intelligence led, spot check, etc. dependent on the stakeholder. However, there was unanimous support for provision of guidance in relation to the authenticity testing of herbs and spices.

Authenticity testing of herbs and spices is a complex matter, and the analytical approaches used for the authenticity testing of herbs and spices are very much dependent on the stakeholder category and the purpose of testing. Spectroscopy-based, mass spectrometry-based and DNA-based techniques feature most in the scientific literature. Within these broad technique categories, Near Infra-Red (NIR) and Polymerase Chain reaction (PCR) are the techniques most commonly used followed by Fourier Transform Infra-Red (FT-IR), Gas Chromatography – Mass Spectrometry (GC-MS), Liquid Chromatography – Mass Spectrometry (LC-MS), microscopy, Next Generation Sequencing (NGS), Ash, Acid-ash, Inductively Coupled Plasma – Mass Spectrometry (ICP-MS) and High Performance Liquid Chromatography (HPLC), which all featured equally in publications.

All methods and technologies used for the authenticity testing of herbs and spices suffer from the same issues of the lack of reliable reference samples, and difficulty of accessing proprietary validated datasets, on which to validate the methods to demonstrate their fitness for purpose. In addition, most Public Analyst (PA) Official Laboratories (OLs) stated they had difficulty in accessing appropriate reference materials and Proficiency Trial (PT) rounds for herbs and spices for authenticity.

Although, there is a wide portfolio of methods used for verifying the authenticity of herbs and spices, the evidence shows a preference for the use of initial rapid screening approaches, within a tiered system of testing, where a non-compliant result can be followed up with appropriate confirmatory tests. In this respect, NIR and FT-IR appear to be gaining favour for use as initial screening tools. Within the UK, Queens University Belfast (QUB) Institute for Global Food Security (IGFS) and Bia Analytical (BA), a commercial subsidiary of IGFS, are recognised as leading experts in the field of NIR and FT-IR for food authenticity testing. BA currently provide FT-IR authenticity testing services for nineteen herbs and spices, two of which have been fully ISO 17025 UKAS accredited (oregano and sage) at QUB.

In the 2022 survey of PA OLs in England conducted by the Government Chemist, methods for herb and spice authenticity were identified as a gap. There is currently no statutory requirement to analyse herbs and spices for authenticity at ports, so it is not routinely undertaken at UK ports. PA OLs stated that herb and spice authenticity is not a priority for local authorities so consequently they receive very few samples for analysis. However, all PA OLs expressed an interest in accessing training in the authenticity testing of herbs and spices. Outside of the PA OL network, there is currently sufficient UK capability and capacity within the private sector, with an addition three international organisations, specialising in herb and spice authenticity testing, also offering commercial services.

Recommendations

Based on the evidence gathered for this project, the following recommendations are proposed:

- Ensure the availability of commercially representative reference samples for the herbs and spices identified as of highest concern.
- Share the results of this report with leading PT providers and seek to influence their future provision of authenticity PT to include spices of concern.
- Provide PA OLs with:
 - The opportunity to visit a herb and spice producer to help gain greater appreciation of the complex supply chains and the processes involved in the commercial production of herbs and spices.
 - Training on food authenticity testing methods with a focus on those that use chemometric and/or machine learning algorithms for data analysis.
- With an inventory of laboratories offering food authenticity testing for herbs and spices.
- Updated training on the use of external DNA databases such as the BOLD and NCBI (GenBank).
- Roll-out the rapid screening method ([footnote 1](#)), coupled with chemometrics, for the economically motivated adulteration of oregano and black pepper to PA OLs. For PA OLs who do not have FT-IR instruments that satisfy the minimum requirements and want to implement the method in their laboratories, FSA should investigate options for them to acquire / have access to appropriate FT-IR instruments and where necessary, specialist sample preparation equipment.
- Assess the costs of implementation of new methods so that PA OLs can be supported to ensure maximum uptake.
- Consider development of guidance / regulator-industry code of practice for authenticity testing of herbs and spices for industry, commercial and control laboratories, and local and port health authorities.

Recommendations for future research have also been made to improve the robustness of methods available for the analysis of culinary herbs and spices for authenticity.

1. UKAS accreditation awarded to QUB for sage and oregano, award pending for remaining 17 herbs and spices. UKAS accreditation to BA for all 19 herbs and spices pending at the time of compiling the report.