



IMPROVING THE CRITERIA FOR DETECTION AND CERTIFICATION OF PESTICIDE RESIDUES IN FRUITS AND VEGETABLES IN UZBEKISTAN

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DOI: <https://doi.org/10.5281/zenodo.17676015>

Abstract: *This study focuses on improving the detection and certification criteria for pesticide residues in fruits and vegetables in Uzbekistan. The research aims to ensure food safety and compliance with international standards by modernizing analytical methods and establishing clear regulatory frameworks. Advanced chromatographic and spectrometric techniques were evaluated to enhance the precision and sensitivity of pesticide residue analysis. The results emphasize the need for standardized laboratory protocols, digital data management, and nationwide monitoring systems. Implementing improved certification mechanisms will contribute to the production of environmentally safe agricultural products, strengthen export potential, and protect public health.*

Key words: *pesticide residues, fruits, vegetables, certification, food safety, analytical methods, Uzbekistan, regulation.*

INTRODUCTION

Ensuring the safety and quality of fruits and vegetables is a critical component of modern agricultural production, both for domestic consumption and international trade. One of the major concerns in food safety is the presence of pesticide residues, which can pose serious health risks if concentrations exceed permissible limits. Pesticides are widely used to protect crops from pests, diseases, and weeds, but their inappropriate application or insufficient regulation can lead to contamination of fruits, vegetables, and ultimately, the human food chain. In Uzbekistan, rapid development of the horticultural and vegetable sectors, along with increasing demand for high-quality and exportable produce, has highlighted the need for effective monitoring and certification of pesticide residues.



Pesticide residue analysis involves the detection and quantification of various chemical compounds that remain in or on agricultural products after treatment. Globally, advanced analytical techniques such as gas chromatography (GC), high-performance liquid chromatography (HPLC), and mass spectrometry (MS) are applied to ensure accurate and sensitive determination of pesticide levels. These methods allow not only the identification of active ingredients but also the quantification of residues at trace levels, often below 0.01 mg/kg. Implementing these advanced methods in Uzbekistan is essential to align domestic food safety standards with international requirements, particularly those of the Codex Alimentarius and the European Union, which regulate maximum residue limits (MRLs) for exported products[1-5].

Despite the importance of pesticide monitoring, several challenges exist in Uzbekistan. These include the lack of standardized laboratory procedures, limited access to modern analytical instruments, inconsistent enforcement of regulations, and insufficient training of personnel in residue analysis. Additionally, regional differences in pesticide usage patterns and crop types complicate the establishment of uniform certification criteria. Therefore, improving both the analytical and regulatory frameworks is crucial to ensure reliable detection of residues and to certify that fruits and vegetables are safe for consumers.

Certification systems for pesticide residues serve several purposes: they provide consumer confidence, facilitate trade, and incentivize growers to adopt good agricultural practices (GAP). An effective certification process requires the integration of robust laboratory analysis, traceability of agricultural products, and transparent documentation of results. In recent years, many countries have introduced digital management systems to streamline data collection, analysis, and certification, thereby enhancing the efficiency and credibility of food safety programs. For Uzbekistan, adopting similar approaches can improve national monitoring, reduce health risks, and increase the competitiveness of agricultural exports.

This study aims to evaluate the current methods used for pesticide residue analysis in Uzbekistan and to propose improvements in the criteria for detection and certification. The objectives include:

1. Reviewing existing laboratory techniques for pesticide residue determination.
2. Assessing the sensitivity, precision, and reliability of these methods.



3. Identifying gaps in current regulatory frameworks for certification.
4. Proposing standardized criteria and procedures to improve detection and certification of residues.

By addressing these objectives, the study seeks to enhance food safety and public health protection while supporting the sustainable development of the horticultural and vegetable sectors. Implementing improved analytical protocols and certification standards will not only ensure compliance with international regulations but also promote the production of high-quality, environmentally safe agricultural products.

Table 1. Comparative analysis of pesticide residue detection methods in fruits and vegetables

Method	Principle	Detection limit (mg/kg)	Advantages	Limitations
Gas Chromatography (GC)	Separation of volatile compounds	0.001–0.01	High sensitivity, suitable for volatile pesticides	Requires derivatization for non-volatile compounds
High-Performance Liquid Chromatography (HPLC)	Separation of liquid-soluble compounds	0.005–0.02	Can detect a wide range of pesticides, including thermolabile ones	Relatively high cost, requires skilled operators

Conclusions

The study emphasizes the critical need to improve the detection and certification criteria for pesticide residues in fruits and vegetables in Uzbekistan to ensure food safety and public health. Analysis of current practices revealed gaps in laboratory standardization, monitoring protocols, and regulatory enforcement, which may lead to inconsistencies in residue detection. Advanced analytical methods such as GC, HPLC, MS based techniques offer higher sensitivity and accuracy, enabling reliable identification and quantification of pesticide residues even at trace levels.

Implementing standardized detection procedures and clear certification criteria will allow for consistent evaluation of residue levels, ensuring that only safe products reach the consumer market. Additionally, integrating digital data management and nationwide monitoring systems will strengthen traceability, enhance regulatory compliance, and support export-oriented agriculture. Improved



certification mechanisms will encourage growers to adopt good agricultural practices, reduce the risk of chemical contamination, and promote the production of high-quality, environmentally safe fruits and vegetables. Overall, these measures will contribute to sustainable agricultural development, increased consumer confidence, and alignment with international food safety standards.

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