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Food Fraud and its Impact on Population Health: the Case of Romania

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Abstract

Food fraud has become a major challenge for public health, market integrity, and agri-food supply chains. This paper examines the concept of food fraud and its impact on population health through toxicological, allergenic, microbiological, and nutritional pathways. It also highlights vulnerable food categories and reviews current detection methods. The study is based on an integrative analysis of scientific literature and recent reports from international and Romanian authorities. Romania is used as a case study, focusing on products such as honey, dairy, meat, fish, spices, oils, and premium beverages, which are particularly exposed due to their high economic value and analytical complexity. The findings indicate that food fraud not only affects health but also undermines traceability, delays risk communication, and reduces consumer trust. The paper emphasizes the need for risk-based controls, advanced laboratory techniques, digital traceability, and stronger collaboration between stakeholders.

Keywords: *food fraud; food authenticity; public health; traceability; food safety; Romania.*

1. Introduction

Food safety represents an essential condition for the protection of public health, while the current scale of global trade transforms any serious non-compliance into an issue with transboundary potential [1,2]. The World Health Organization estimates that approximately 600 million people fall ill each year after consuming contaminated food, and 420,000 deaths occur annually, with children under the age of five bearing a disproportionate burden of foodborne diseases [1]. In this context, any intentional practice that alters the identity, composition, or origin of food must be analysed not only as a commercial irregularity, but also as a factor with direct relevance for public health, consumer trust, and the functioning of control systems [2,3].

In the scientific literature, food fraud is defined as the intentional act by which an economic operator or another actor within the agri-food chain misleads the buyer in order to obtain undue economic gain [4]. The conceptual definition has been further consolidated through studies on economically motivated adulteration, which have demonstrated that intentionality and economic benefit distinguish fraud from simple technological error or accidental non-compliance [5,6]. In practice, food fraud may take various forms, including adulteration, dilution, ingredient or species substitution, false labelling, counterfeiting, origin fraud, and manipulation of traceability documents [7–9].

An essential element, often insufficiently addressed, is the distinction between accidental hazards and deliberate fraud [10]. Traditional food safety management systems have been primarily designed to control process variability and unintentional errors, whereas food fraud operates under a different logic [11,12]. The fraudulent actor actively adapts the product, documentation, and commercial communication in order to maximise profit while minimising detectability

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[13,14]. For this reason, food fraud risk assessment must consider not only the probability of hazard occurrence, but also economic motivation, ease of substitution, masking potential, and the actual capacity for detection through appropriate analytical methods [10,11,14]. From a public health perspective, the severity of the phenomenon does not depend exclusively on the presence of immediate toxic effects [4]. Even in the absence of acute incidents, food fraud reduces the capacity of the food system to accurately assess risks, rapidly communicate hazards, and efficiently withdraw compromised batches [9,13]. It undermines consumer trust in labelling, certification, and regulatory institutions, generates losses for honest operators, and creates a market environment in which economic performance may be achieved through the circumvention of technical standards [14]. Consequently, food fraud should be understood as a phenomenon situated at the intersection of economic crime, food process engineering, and population health [4,9].

For Romania, the topic is particularly relevant due to its integration into the European single market, the national agri-food profile, and the prevalence of high-risk products - such as honey, milk, meat products, fish, oils, spices, and premium beverages - which increase both opportunities for fraud and the need for robust authentication mechanisms [15,16]. Against this background, the objective of the present paper is to analyse the mechanisms of food fraud, its impact on population health, high-vulnerability food matrices, and priority intervention directions for the Romanian context, in relation to the requirements of European official controls [17–19].

2. Materials and method

The present study is designed as an integrative review, with an applied component in the form of a case study focusing on Romania. The choice of this design was determined by the fact that the phenomenon of food fraud simultaneously spans multiple fields, including food safety, analytical chemistry, supply chain management, food law, and public policy. Consequently, an exclusively experimental or purely legal approach would have been insufficient to capture its multidimensional nature.

For the present review, a systematic literature search was conducted across several relevant databases, including Web of Science, Scopus, PubMed, ScienceDirect, and Google Scholar. The search strategy employed keywords such as “food fraud”, “food adulteration”, “food authenticity”, “economically motivated adulteration”, “food traceability”, “honey adulteration”, “milk adulteration”, “species substitution”, and “Romania”. In addition to articles, official documents issued by the European Commission, the World Health Organization, the Food and Agriculture Organization, and national control authorities, especially the Romanian National Sanitary Veterinary and Food Safety Authority (ANSVSA), were also used. The time frame considered was 2007 to 2025, ensuring comprehensive coverage of both the conceptual foundations and recent developments in the field.

After removing duplicate records, studies investigating the mechanisms of food fraud, its impact on public health, and modern detection and authentication methods were prioritised. The selection process included an initial screening phase based on the evaluation of titles and abstracts, followed by a full-text assessment of relevant articles, ensuring a rigorous and systematic approach to literature selection.

The inclusion criteria were as follows:

- peer-reviewed journal articles and review papers published in English;
- studies addressing food fraud, food authenticity, and detection methods;
- research analysing the impact of food fraud on public health and/or the agri-food supply chain; official documents issued by international organisations (European Commission, World Health Organization, Food and Agriculture Organization) and relevant national authorities.

Exclusion criteria were established to omit studies that:

- did not directly address food fraud or food authenticity;
- lacked methodological detail or relevant results;
- were published in languages other than English without an accessible English translation.

The selected articles underwent systematic evaluation, with key information extracted regarding publication year, authors, study objectives, methodology, main findings, and conclusions.

The synthesised data enabled the identification of emerging trends, areas of agreement, and inconsistencies within the literature, contributing to a coherent and critical analysis of food fraud and its implications for population health. This methodologically robust approach reflects a commitment to thoroughly integrating and interpreting current knowledge in the field.

The analysis was structured along four main axes: (i) the conceptual delineation of food fraud; (ii) the

identification of pathways through which it impacts population health; (iii) the assessment of high-vulnerability food matrices and modern authentication methods; and (iv) the development of an interpretative profile for Romania, based on official documents and coordinated actions at the European Union level. The focus was not on the exhaustive quantification of incidents, but rather on understanding the mechanisms that transform an economic irregularity into a risk for public health and for the proper functioning of the market.

3. Results and Discussion

3.1. Conceptual framework and determinants of food fraud

From a technological and legal perspective, food fraud encompasses adulteration, dilution, ingredient or species substitution, false labelling, misrepresentation of geographical or botanical origin, the use of non-compliant documentation, and product counterfeiting [8]. The rigorous delineation of these forms is essential, as each generates a distinct risk profile [20,21]. For example, species substitution may introduce unexpected allergens or biological agents, while chemical additives used to mask quality deficiencies may pose direct toxicological risks [22]. The typology of food fraud and its relevance to public health are summarized in Table 1.

Conceptually, not every authenticity issue necessarily constitutes fraud, but every act of fraud implies a compromise of both authenticity and food integrity [5]. Authenticity refers to the correspondence between the declared and actual identity of the product, while integrity concerns the preservation of its essential characteristics throughout the supply chain [6,23]. Economically motivated adulteration describes the deliberate alteration of composition in order to obtain financial gain [8,9]. This distinction is particularly useful because it separates accidental non-compliances from intentional misconduct and enables the design of differentiated responses at both the official control level and the level of economic operators [5,6,9].

Table 1. Typology of food fraud and its relevance to public health

Type of fraud	Technical mechanism	Common examples	Public health relevance
Dilution	Addition of low-cost substances or reduction of the concentration of valuable components	Water in milk; syrups in honey; undeclared mixtures in oils	Reduced nutritional value; toxicological risk if unauthorised compounds are used
Ingredient / species substitution	Replacement of an ingredient or species with a lower-cost alternative	Undeclared fish or meat species; vegetable fats in dairy products	Undeclared allergens; microbiological risk; dietary incompatibilities
False labelling	Provision of incorrect information regarding composition, origin, or processing	Fictitious geographical origin; unjustified “organic” or “premium” claims	Consumers are unable to correctly assess risk or actual quality
Documentary fraud	Manipulation of certificates, batches, and traceability records	Falsified import documents; non-compliant botanical origin	Delays in investigation and withdrawal of non-compliant products

Vulnerability mechanisms can be explained through the interaction between economic pressure, supply chain complexity, information asymmetry, and weak control systems [10,11]. Premium products, products marketed in powdered, filleted, or highly processed forms, as well as supply chains involving multiple intermediaries, are particularly exposed, as direct sensory verification becomes difficult and the gap between declared value and the actual cost of substitutes can be substantial [12,24]. Under such conditions, food fraud is not merely a market anomaly, but rather an opportunistic choice facilitated by commercial [10,13].

Moreover, vulnerability should be assessed not only in relation to the product itself, but also in terms of contractual relationships and the organisation of supplier networks [11,12]. Price volatility of raw materials, pressure on delivery timelines, outsourcing of critical operations, and dependence on brokers or difficult-to-audit suppliers significantly increase the likelihood of fraudulent practices [13]. Therefore, food fraud vulnerability assessment should become a continuous process, integrated with economic data, supplier history, and testing plan outcomes, rather than a formal document merely attached to the HACCP system [11,12].

In practice, food fraud must be addressed simultaneously as an issue of integrity and safety. Regulation (EU) 2017/625 requires Member States to organise risk-based official controls and to identify fraudulent and deceptive practices, while the

IMSOC framework supports information exchange through networks such as ACN, AAC, RASFF, and FFN [17,18]. For a Member State such as Romania, the effectiveness of intervention depends not only on inspection capacity, but also on the speed with which suspicions are translated into evidence, analytical results, notifications, and corrective measures with a real impact on the market [19].

3.2. Public Health Implications

Food fraud affects population health through several converging mechanisms. The first is the toxicological mechanism. The causal chain of food fraud and its effects on public health is illustrated in Figure 1.When a product is adulterated with unauthorised substances, residues, or compounds used to mask dilution, spoilage, or poor appearance, the risk to consumers may become immediate [25,26]. The literature on milk, fish, confectionery products, and beverages has documented cases in which colourants, preservatives, formaldehyde, sweeteners, and other compounds were illegally used to simulate freshness, colour, or commercial quality [22,27].

The second mechanism is allergological. False labelling, ingredient substitution, or unreported cross-contamination expose consumers to undeclared allergens. For individuals with hypersensitivity to proteins from milk, fish, crustaceans, eggs, gluten, soy, or nuts, even a seemingly minor discrepancy between the declared and actual product may trigger severe effects, including anaphylactic reactions [20,21]. From this perspective, food fraud is no longer merely a matter of consumer deception, but a clinical safety issue [22].

The third mechanism is microbiological. When the actual product differs from the declared one, the microbiological hazard profile is implicitly altered. A substituted fish species or a meat raw material of different origin may have distinct sanitary histories, microbial loads, or storage requirements incompatible with those applied to the declared product [28,29]. In such situations, fraud not only conceals composition, but also distorts the entire model of microbiological risk assessment and shelf-life management [9,30].

A nutritional mechanism also exists, although it is often given less attention than it deserves. Dilution, substitution with lower-quality raw materials, and clandestine reformulation reduce nutritional density and may alter the lipid, protein, or carbohydrate profile of the product [20,26]. For vulnerable groups - such as children, the elderly, individuals with chronic diseases, or those following specific medical diets - these changes may have disproportionate consequences [22,31]. Thus, even in the absence of an acute toxic event, food fraud generates health costs by reducing nutritional value and compromising dietary adequacy.

In addition to these mechanisms, there is an institutional and psychosocial dimension. Food fraud erodes consumer trust in labelling, certification, and the ability of authorities to ensure market integrity [4,13].This loss of trust generates indirect costs, including costly product recalls, harm to honest producers, market distortion, and reduced public responsiveness to legitimate risk communication [9,14]. From a public health perspective, this impact is significant, as weakened trust may compromise the effectiveness of official communication in real emergency situations.

The effects are not evenly distributed across the population. Children, elderly individuals, pregnant women, immunocompromised patients, and people with food allergies or medical diets are more exposed to disproportionate consequences [1]. In these groups, the discrepancy between declared and actual composition decisively alters the risk profile. For this reason, the assessment of food fraud should not be separated from the evaluation of consumer vulnerability, nor from the analysis of actual product use within the diet [22].

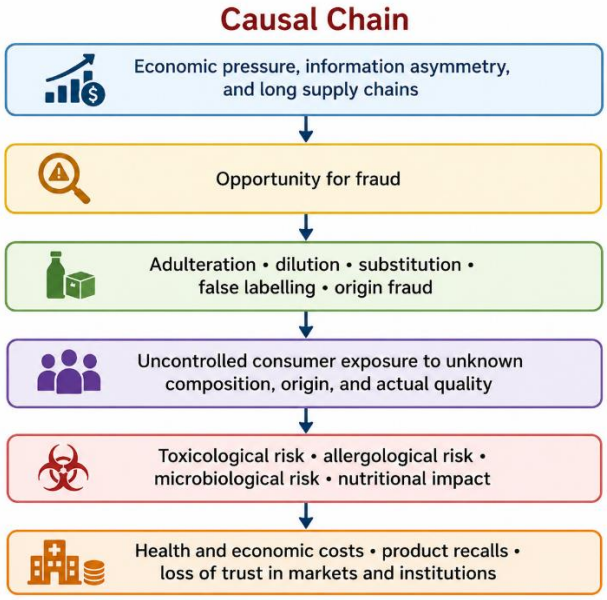

Figure 1. Causal chain of food fraud and its effects on public health

3.3. High-Risk Food Matrices

Food fraud is not evenly distributed across product categories. Vulnerability increases where raw

materials have high commercial value, where the final product is difficult to verify through sensory analysis, where supply chains are long, or where claims regarding origin, species, production method, or "premium" status add a significant economic premium [5,9]. From this perspective, honey, milk and dairy products, meat, fish, spices, herbs, oils, coffee, wine, and other geographically identified beverages are recurrent categories in both scientific literature and European official reports [14]. The main vulnerable food matrices, the dominant forms of fraud, and their specific implications for Romania are summarized in Table 2.

Table 2. Vulnerable food matrices, dominant forms of fraud, and implications for Romania

Matrix	Dominant forms of fraud	Potential consequences	Relevance for Romania
Honey	Addition of exogenous sugars; falsification of botanical and geographical origin	Alteration of compositional profile; inability to assess authenticity	Important apicultural sector and exposure to increased European requirements
Milk and dairy products	Dilution; substitution of milk fat; additives used to mask spoilage	Reduced nutritional value; toxicological risk	High consumption and sensitive technological chain
Meat and fish	Species substitution; misleading labelling regarding origin	Undeclared allergens; microbiological risk	High importance in consumption and traceability controls
Spices and herbs	Undeclared plant material; unauthorised colourants	Exposure to allergens and contaminants	High relevance in import and processing
Oils, coffee, wine	Undeclared mixtures; false geographical origin	Consumer deception; difficulty in quality assessment	Premium segments with significant economic value

Honey remains one of the most sensitive matrices at both European and global levels. Its compositional complexity, the economic premium associated with botanical and geographical origin, and the availability of low-cost syrups favour adulteration through the addition of exogenous sugars [32,33]. Review studies and coordinated actions at the European Union level indicate that honey authenticity requires high-resolution analytical methods, including isotopic and spectrometric profiling; in a European Commission coordinated action on imported honey, 46% of the 320 samples analysed raised suspicions of non-compliance, confirming the persistence of risk in this sector [16,34,35].

For Romania, honey has particular significance, as it simultaneously holds economic, cultural, and technological importance. In practice, honey authenticity cannot be reduced to a single laboratory test; the relationship between sugar profiles, botanical markers, isotopic signatures, and technological history must be interpreted in an integrated manner [32,33]. This complexity explains why single screening methods are useful for sample selection but insufficient for definitive conclusions without confirmation through complementary approaches [16,34].

Milk and dairy products are vulnerable to dilution, substitution of milk fat, and the addition of compounds intended to mask spoilage or quality reduction. The literature has repeatedly documented the use of water, starch, neutralisers, detergents, or unauthorised preservatives in milk and dairy products [25,36]. From an engineering perspective, this category remains critical because the raw material is perishable, processing is continuous, and the economic incentive for dilution is immediate, with direct consequences for nutritional value and product safety [31,37].

Meat, meat products, and fishery products present a high risk of species substitution and misleading labelling regarding origin or production method. In the case of fish, marketing in filleted or processed forms reduces the consumer's ability to verify species authenticity, while the distance from the place of capture complicates verification of origin and cold chain integrity [38,39]. For certain species, discrepancies between the declared and actual product may lead to exposure to different parasites, heavy metals, or residues, which is why the literature on fishery products treats authenticity as a full food safety issue [28–30,40].

Spices, herbs, oils, coffee, wine, and other premium beverages are also categories with high vulnerability. In the European Union coordinated plan on herbs and spices, the overall rate of suspicious samples was 17%, reaching 48% for oregano, indicating a substantial risk of adulteration with undeclared plant materials or unauthorised colourants [24]. For olive oil, coffee, and wine, fraud frequently involves undeclared mixtures, false geographical origin, and artificial simulation of

quality, requiring authentication approaches that combine analytical chemistry, documentary evidence, and technological knowledge of the production process [41–46].

From a practical perspective, these categories are relevant for Romania not only because they are widely consumed and traded, but also because they combine exactly those characteristics that make control difficult: high compositional variability, dependence on origin, brand value, and the possibility of processing into mixtures. Consequently, an effective prevention and detection programme must integrate data on consumer exposure, product economic value, and the feasibility of confirmatory analyses, so that control efforts are directed toward matrices with the highest risk yield [13,14,19].

3.3. Advanced methods for food authentication and fraud detection

Modern control of food fraud can no longer rely exclusively on the verification of documents and labels. Chromatographic and spectrometric methods remain essential for the detection of compounds of interest, adulterants, and abnormal chemical profiles, while NIR, FTIR, and Raman spectroscopy, combined with chemometric models, offer the advantage of rapid and non-destructive screening [38,47]. In addition, IRMS and other isotopic techniques are extremely useful for determining origin and detecting the addition of sugars in honey, beverages, and lipid products [48–50]. The main families of analytical methods relevant for food fraud detection are summarized in Table 3.

Table 3. Families of analytical methods relevant for food fraud detection

Method	Main application	Advantages	Limitations
GC-MS / LC-MS / HPLC	Identification of marker compounds, adulterants, and residues	High sensitivity and specificity	High costs; requires specialised personnel
NIR / FTIR / Raman + chemometrics	Rapid screening for authenticity and mixtures	Non-destructive; suitable for routine control	Requires robust reference databases
PCR / qPCR / DNA barcoding / HRM	Species authentication in meat, fish, and mixed products	Highly effective when morphological features are lost	Less useful for non-biological adulterants
IRMS and isotopic profiling	Verification of origin and detection of sugar addition	Particularly useful for honey and premium beverages	Expensive equipment and limited availability
Metabolomics / foodomics	Untargeted detection of complex fraud patterns	Enables identification of unexpected frauds	Interlaboratory standardisation still under development
Blockchain / AI / digital traceability	Prevention and predictive analysis of vulnerability	Supports documentary control and transparency	Cannot independently confirm product composition

From a methodological perspective, the current trend is not to oppose targeted and untargeted methods, but to integrate them into a sequential strategy. Rapid screening is used to identify batches with a high probability of non-compliance, targeted methods validate specific markers, and untargeted approaches capture unexpected compositional patterns and can detect frauds not yet fully described in databases (47,48). This multi-layered logic is particularly important in complex matrices such as honey, wine, coffee, oils, and spice mixtures [50,51].

DNA-based methods - including PCR, qPCR, DNA barcoding, HRM, and increasingly sequencing techniques - are indispensable for species authentication in meat, fish, and mixed products. Their main advantage lies in the ability to identify raw materials even when processing has removed visible morphological features [38,40]. However, these methods cannot independently address all types of fraud, particularly when adulteration involves chemical composition, sugar addition, or falsification of geographical origin [39,52].

Untargeted approaches - such as metabolomics, proteomics, foodomics, and spectral fingerprinting - represent one of the most promising directions, as they can detect global anomalies in product profiles without focusing on a single marker [47,53]. They are particularly useful in premium products, where fraud may be sophisticated and adaptive [48,51]. However, these approaches require robust reference libraries, well-validated chemometric models, and interlaboratory collaboration to avoid statistical overfitting and overinterpretation of results.

Digital tools must be interpreted with technical realism. Blockchain can strengthen documentary integrity and limit retrospective manipulation of

batch traceability, but it cannot independently demonstrate the chemical or biological authenticity of a product [54]. Similarly, artificial intelligence models can enhance screening capacity and identify suspicious patterns in large datasets, but their performance depends on data quality and the representativeness of reference samples [14,55]. Consequently, digitalisation should be viewed as a component of the solution, not a substitute for analytical chemistry, molecular biology, and human laboratory expertise.

From an engineering perspective, the key conclusion is that no single method can address all configurations of food fraud. An effective strategy requires combining vulnerability assessment with rapid screening techniques, followed by confirmatory methods tailored to the food matrix and the analytical question. This approach reduces overall control costs, increases detection probability, and enables better prioritisation of laboratory resources within both official control programmes and operator self-monitoring systems [14,38,49,50].

3.4. Case Study: Romania

3.4.1. Structural context

The analysis applied to Romania must be approached with caution: not all fraud suspicions identified within European networks automatically represent confirmed incidents on the domestic market, yet they provide valuable insights into product types, vulnerability mechanisms, and the areas in which risk-based control should be strengthened. The structural relevance of the Romanian case arises from the combination of three elements: full integration into the European single market, the existence of agri-food sectors with strong identity value, and simultaneous exposure to import, processing, blending, and intra-EU redistribution.

The significance of this positioning is clear: economic operators in Romania operate within the same commercial space in which fraud involving honey, spices, fish species, oils, beverages, and products of animal origin is investigated at a transboundary level. Data and synthesis reports from the European Commission for 2024 confirm that food fraud suspicions remain persistent at the European scale, requiring Member States to treat the phenomenon as a structural rather than episodic issue [19].

The relevance for Romania is further supported by the participation of Member States, including Romania, in coordinated actions targeting products such as honey and herbs and spices. These actions are important not only for their specific findings, but also because they demonstrate that modern food fraud investigation requires a combination of sampling, laboratory analysis, traceability, and administrative cooperation. For Romania, the key lesson is that products with high commercial value and origin-dependent identity must be prioritised in both official control programmes and operator self-control plans [15,16,42].

3.4.2. Institutional and Operational Framework

At the institutional level, the prevention and control of food fraud depend on the coherent coordination of multiple actors, including economic operators, laboratories, competent authorities, and European information exchange networks. The role of the Romanian National Sanitary Veterinary and Food Safety Authority (ANSVSA) is central within this framework, both through official controls and monitoring programmes, and through its capacity to coordinate with territorial structures and European administrative cooperation platforms. The main levels of intervention and the relevant instruments for preventing food fraud in Romania are summarized in Table 4.

From a functional perspective, effectiveness is not determined solely by the number of controls, but by the ability to direct resources toward batches, products, and operators where the combination of economic motivation and potential health consequences is highest [18,19,56,57].

For products of animal origin, national priorities should focus on raw material authentication, traceability validation, and control of the consistency between documentation, labelling, and actual composition. For honey, spices, oils, and premium beverages, the emphasis should be placed on combining rapid screening with confirmatory methods capable of validating origin, composition, and the presence of any unauthorised additions. In all these areas, technical universities, research institutes, and specialised laboratories can play a strategic role in developing reference databases, validating methods, and training personnel involved in control and expertise [14,38,47,57].

In practice, Romania requires a risk-based intervention model rather than uniform control across all products. This implies integrating data on product economic value, supplier history, supply chain complexity, frequency of non-compliance, and the feasibility of confirmatory analyses. Such an approach enables a shift from a reactive, incident-driven logic to a preventive, vulnerability-based approach aimed at building a more resilient food integrity system [11–13,19].

Table 4. Levels of intervention and relevant instruments for preventing food fraud in Romania

Level / actor	Instruments and responsibilities	Main function	Critical observation
European Union	Regulation (EU) 2017/625; IMSOC; ACN, AAC, RASFF, FFN; coordinated thematic actions	Regulatory framework, information exchange, and transboundary cooperation	Effectiveness depends on the quality and timeliness of national notifications
ANSVSA and territorial structures	Risk-based official controls; sampling; corrective measures; reporting and coordination	Operational implementation of control on the domestic market	Smart prioritisation of products and operators is decisive
Official laboratories and academia	Confirmatory methods; validation; reference databases; technical expertise	Transformation of suspicion into robust analytical evidence	Laboratory capacity must be aligned with actual risk profiles
Economic operators	Supplier audits; authenticity specifications; internal traceability; testing plans	Primary prevention and early detection	Formal self-control without real verification has limited effectiveness
Consumers and market	Complaints; basic label verification; reputational pressure	External signal and driver for transparency	Cannot replace official and analytical control

3.5. Risk management and public policy implications

Combating food fraud requires a multi-level control architecture. At the level of economic operators, food fraud vulnerability management should complement, rather than duplicate, traditional food safety systems. Supplier approval, clear technical specifications for raw materials, mass balance verification, monitoring of unusual price variations, and the implementation of authenticity testing plans represent concrete tools through which operators can reduce fraud opportunities before products reach consumers [11–13].

At the level of official control, the most effective approach is risk-based. This implies prioritising sampling and inspection toward premium products, highly processed products, batches with difficult-to-verify origin, supply chains involving multiple intermediaries, or operators with relevant compliance histories. At the same time, rapid information exchange through AAC, RASFF, FFN, and ACN reduces the time between suspicion, investigation, and corrective action, and this reduction is critical for limiting population exposure and maintaining trust in the system [17–19].

A third layer concerns scientific and laboratory infrastructure. The development of analytical capacity should not be assessed solely by the number of available instruments, but by their suitability for the types of fraud relevant to the domestic market, the existence of validated protocols, and interlaboratory cooperation. In the absence of robust reference databases and close collaboration between authorities, universities, and specialised laboratories, even advanced methods may have limited practical utility [38,47,48,51].

Digitalisation and predictive analytics can provide significant advantages, particularly in long and fragmented supply chains. However, their real benefit emerges only when commercial data, traceability documentation, and analytical results are integrated into a coherent surveillance model. Otherwise, digitalisation risks becoming merely a formal compliance exercise. In this area, meaningful investment is required not only in software, but also in data standardisation, interoperability, and analytical competencies for interpretation [14,54,55].

Finally, consumer food literacy should be understood as a complementary measure, not a substitute for official control. An informed consumer may identify implausible labels, unusually low prices, or exaggerated commercial claims, but cannot replace analytical expertise. Therefore, consumer education, operator transparency, and official control must function as convergent elements of the same prevention strategy [8,9,13].

4. Conclusion

Food fraud represents a complex issue situated at the intersection of economic crime, food engineering, analytical chemistry, and public health. It cannot be reduced to simple consumer deception, as it affects the capacity of the food system to accurately assess risk, communicate hazards, and maintain the functionality of traceability systems. Potential toxicity, undeclared allergens, alterations in microbiological profiles, and reduced nutritional value transform food fraud into a real threat to population health.

The present analysis shows that honey, milk and

dairy products, meat, fish, spices, oils, coffee, and premium beverages are high-vulnerability matrices, and their authenticity cannot be rigorously assessed without a combination of analytical methods, documentary control, and technological knowledge of the production process. For Romania, this relevance is amplified by its integration into the European single market and the presence of products with strong economic and symbolic identity, for which fraud may generate simultaneous health, reputational, and commercial costs.

Consequently, an effective response for Romania requires prioritising high-risk matrices, strengthening laboratory authentication capacity, integrating digital traceability, reinforcing cooperation with European networks, and actively involving academia in method validation and specialist training. From both an engineering and public policy perspective, the transition from post-factum reaction to vulnerability-based prevention remains the essential condition for limiting food fraud and protecting population health.

Conflicts of interest / Competing interests: No conflict of interest.

Ethics approval: No ethic situation.

Availability of data and material: The data have been reviewed depending on the literature.

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