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Food Forensics in Criminal Justice: Evidentiary Value in Food Adulteration and Fraud Cases

POOJA S*

ABSTRACT

Food adulteration and food fraud have become serious threats to public health, consumer rights, and regulatory compliance. Increasingly, these acts are not merely breaches of regulation but crimes in their own right. Because food fraud has grown sophisticated, encompassing ingredient substitution, contamination, mislabelling, and the use of hazardous additives, the criminal justice system requires far stronger investigative methods. It is in this context that food forensics has assumed importance. It is a discipline that unites scientific and legal work to detect, examine, and prove food crimes. This article examines the role of food forensics in criminal justice, and in particular its value as evidence in prosecutions for food adulteration and fraud. It considers how techniques such as DNA analysis, chromatography, spectroscopy, and isotope profiling are used to detect adulterants and to confirm the identity and origin of food products. The study also considers how such scientific proof makes investigations stronger and more accurate and enables evidence to satisfy the courts' standards of admissibility. The legal framework governing food safety and criminal liability, with particular reference to India, is assessed alongside an examination of how the law is designed to operate and how it is enforced. The principal difficulties are identified: an absence of standardised procedures, questions about the reliability of the evidence, adherence to correct legal procedure, and a shortage of resources in forensic laboratories. The article argues that scientific advances must be aligned with legal reform in order to make the successful prosecution of, and accountability for, food crimes more attainable. It concludes that food forensics is essential to protecting public health and to maintaining confidence in the criminal justice system.

Keywords: Food forensics, food adulteration, food fraud, criminal justice system, forensic evidence, DNA analysis, chromatography, food safety law, evidentiary value, public health protection.

* Author is a Student at The Tamil Nadu Dr. Ambedkar Law University, Chennai, Tamil Nadu, India.

I. INTRODUCTION

Food safety has long been a matter for regulators and medical practitioners to address. However, the deliberate adulteration of food and the growing prevalence of counterfeits have made it far more a concern for the criminal justice system. Across the world, in wealthier and poorer nations alike, food-related crimes have grown in both scale and complexity; they frequently involve the deliberate alteration of food in order to maximise profit. This includes adding harmful substances, substituting ingredients, misstating the origin of food, and wholly counterfeiting popular branded products. These acts breach regulatory rules, endanger public health, and can cause serious illness or even death.

In India, controlling the adulteration of food has long been difficult, and it was historically handled through regulatory rules and the authorities that enforced them. The food sector, however, is changing: food travels across the world, distribution routes are complex, and new technologies are being used. As a result, the older enforcement methods no longer suffice. Food fraud today is generally a carefully planned, systematic means of making money, and the response must therefore shift from merely ensuring that food businesses follow the rules to actively investigating offenders and bringing them to court. This shift underscores the importance of using science as part of the legal process.

Food forensics is a crucial science in this changing landscape. It applies scientific methods to determine the true composition of food, whether it is what it purports to be, and whether it is safe to consume. Unlike ordinary food testing, this forensic analysis is directed specifically at producing evidence that will be accepted in court. Using methods such as DNA testing, the separation of substances through chromatography, the identification of materials through spectroscopy, and tracing through isotopes, investigators can identify adulterants, confirm origin, and prove fraud with considerable accuracy. Food forensics thus connects the laboratory and the courtroom.

From the standpoint of the justice system, the proof that food forensics provides is of considerable value. In a criminal trial, the court must be satisfied beyond reasonable doubt, and scientific evidence is frequently decisive as to whether an accused person is guilty. Forensic reports, if the samples are properly collected, stored, and analysed, provide impartial and dependable proof in support of a prosecution. For such evidence to be admissible, however, strict procedures must be followed: a clear record of who has handled the food, accreditation of the laboratories, and adherence by expert witnesses to professional standards. Any deficiency in these areas will weaken the proof and may alter the outcome of the case.

India's food-safety laws, principally the Food Safety and Standards Act, 2006¹ and provisions of the Indian Penal Code, 1860,² both regulate food and punish offenders. These laws provide a foundation, but their effectiveness depends largely on the use of forensic science in investigations. The increasing reliance on scientific proof in food crimes reflects a broader movement towards evidence-based decision-making in criminal cases.

This article therefore offers a thorough examination of the role of food forensics in the criminal justice system, and in particular its value as proof in cases of food adulteration and food fraud. It seeks to achieve several objectives: to examine the scientific methods that food forensics uses for investigation, to assess the legal rules governing the admissibility of forensic proof in court, and to study the effectiveness of the existing laws and their enforcement. It also identifies the problems and gaps in the present system and suggests ways to strengthen the use of forensic science in upholding food law. By examining food forensics from both a scientific and a legal standpoint, the study demonstrates its importance to securing accountability, protecting public health, and enhancing confidence in the justice system.

II. AIM AND OBJECTIVES OF THE STUDY

This study is a careful examination of the role of food forensics in the criminal justice system, and in particular its value as proof where food has been adulterated or falsely sold. It explores how science is used to detect these problems, to establish authenticity, and to create robust evidence capable of withstanding scrutiny in court. It also assesses how effectively the current laws in India address these issues.

The objectives of this study are to explore and analyse the intersection of food forensics and criminal justice in a structured manner. The study focuses on both scientific and legal dimensions in order to provide a comprehensive understanding of the subject.

- To examine the concept, scope, and significance of food forensics as an emerging interdisciplinary field within the criminal justice system.
- To analyse the nature and various forms of food adulteration and fraud, and to understand their classification as criminal offences affecting public health.
- To study the application of scientific techniques such as DNA analysis, chromatography, and spectroscopy in detecting food-related violations and establishing evidentiary facts.

¹ The Food Safety and Standards Act, 2006, No. 34, Acts of Parliament, 2006 (India).

² The Indian Penal Code, 1860, No. 45, Acts of Parliament, 1860 (India).

- To evaluate how these scientific findings translate into legal evidence and their role in strengthening prosecution.

III. RESEARCH ISSUES

- Whether food adulteration and fraud should be treated as serious criminal offences rather than mere regulatory violations, particularly in light of their impact on public health and safety.
- To what extent food forensic techniques provide reliable and admissible evidence in criminal proceedings, especially in meeting judicial standards of proof and evidentiary requirements.
- Whether the existing legal framework in India is adequate to address modern and sophisticated forms of food fraud, including the effectiveness of enforcement mechanisms and penal provisions.
- What the major procedural and practical challenges affecting the use of forensic evidence are, such as issues in sample collection, chain of custody, laboratory delays, and the lack of standardisation, and how these affect successful prosecution.

IV. CONCEPT AND SCOPE OF FOOD FORENSICS

Food forensics is a relatively new field that combines several scientific disciplines to examine food. It uses scientific methods to determine whether food is what it purports to be, what it contains, where it came from, and whether it is safe to consume. Ordinary food testing is largely concerned with regulatory compliance, whereas food forensics is concerned with investigation and with providing proof for court proceedings; it is intended to yield firm, scientific conclusions that can be used in law. In essence, it turns food into something that can serve as evidence of a crime and as a means of establishing the truth of what occurred.

It is built upon principles drawn from analytical chemistry, molecular biology, and forensic science. Food forensics has developed because of the growing complexity of the journey of food from source to table, and because food is increasingly adulterated for financial gain. As food passes through many different regions of the world and many different legal systems before it is purchased, the opportunities for cheating, contamination, and misdescription increase. In these circumstances, the usual methods of checking food are insufficient; sophisticated scientific tools capable of detecting even the smallest deviation from what is required are needed.

Food forensics addresses a broad range of matters and has many applications. It is not limited to identifying something that ought not to be in the food; it involves a comprehensive assessment of the overall quality of the food. This means confirming authenticity, ascertaining exactly where and how the food was grown or raised, and identifying any unauthorised changes. In a criminal case, this type of investigation is central to establishing what the offence involved and connecting it to the accused.

Broadly, the scope of food forensics may be understood through the following dimensions.

A. Detection of adulteration

Food forensics determines whether a substance that ought not to be present has been added to food, or whether something harmful has been introduced. This may include artificial chemicals, manufactured additives, or the extension of food with cheaper, lower-quality ingredients. The ability to detect even very small quantities of such substances is of great importance in proving that food has failed to meet safety standards.

B. Authentication and identification

Food forensics verifies whether the contents of food are truly what the packaging states. Forensic science can, for example, determine whether a product sold as "pure honey" or "organic produce" genuinely is what it claims to be, and in doing so exposes instances of mislabelling or sale by deception.

C. Source attribution and traceability

Establishing where food comes from is a particularly important aspect of food forensics. By examining its isotopes and molecules, investigators can determine a food product's place of origin, the manner in which it was produced, and the stages through which it passed on its way to the consumer. This is especially useful in identifying counterfeit foods and products that have been imported unlawfully.

D. Detection of contaminants and toxins

Food forensics also plays a role in identifying harmful contaminants, including pesticides, heavy metals, and microbial toxins. This is crucial not only for public health but also for establishing criminal negligence or intent.

Although food forensics is founded on the principles of food science, it is distinguished by the law. When a substance is analysed for legal purposes, every step, from collecting the sample to testing it in the laboratory and writing the report, must be carried out exactly in accordance with the rules so that the results will be admissible in court. This requires a fully documented record

of who has held the sample, validated laboratory methods, and experts who are properly trained to explain the results. It is therefore a matter not only of science but also of correct procedure and the proof required for a case.

Food forensics is also designed to deter and discourage food fraud. The knowledge that reliable means exist for detecting the misdescription or alteration of food makes such conduct less likely. Food authorities and the police use forensic checks and the testing of random samples to ensure compliance with the rules. Used in this way, food forensics enables problems to be identified quickly and greatly reduces the likelihood that large numbers of people will fall ill.

As food forensics expands, however, it grows more complex. Interpreting the science behind the data requires considerable skill, and even small variations in how a test is performed can occasionally yield different results. Moreover, because laboratories do not all apply exactly the same standards, ensuring that results are consistent and trustworthy can be difficult. These difficulties point to the need for greater standardisation, laboratory accreditation, and the continual improvement of forensic techniques.

In the context of criminal trials, food forensics connects scientific investigation to what will be accepted in court as proof. It converts technical findings into solid evidence capable of establishing guilt to a very high degree of certainty. As food-related crimes grow more complex, food forensics will undoubtedly become even more important to enforcement agencies.

V. NATURE AND FORMS OF FOOD ADULTERATION AND FRAUD

Food adulteration and food fraud are significant and complex problems for both food safety and the justice system. Traditionally, adulteration meant the addition of an inferior or harmful substance to food, but the modern concept of food fraud encompasses a wide range of deceptive practices. These practices arise chiefly from the desire to maximise profit, pursued by degrading quality, misdescribing food, or interfering with its distribution. Food crimes are therefore not simply breaches of regulation; they are frequently part of organised, planned criminal activity.

Strictly speaking, adulteration occurs where the quality of food is diminished because something is added, substituted, or removed, altering the natural character of the food. This may happen deliberately or accidentally. Deliberate adulteration, undertaken knowingly for profit and with the potential to cause harm, is the most serious form. Examples include diluting milk or doing so with a substitute substance, adding artificial colour to make spices appear brighter, and mixing cheap oils with superior ones. Such acts clearly demonstrate criminal intent and are frequently punishable by law where they place the public at risk.

Adulteration may also occur by chance, through carelessness, poor handling, or improper storage. The entry of pesticides, heavy metals, dust, and other extraneous matter into food falls within this category. Although there is no intention to cause harm, these situations may still give rise to legal consequences, particularly where negligence causes damage or contravenes official safety rules. The distinction between intentional and accidental adulteration is therefore significant in the eyes of the law, affecting the degree of culpability attributed to the offender and the applicable punishment.

Related to adulteration are substitution and dilution: the use of lower-quality ingredients wholly or partly to replace superior ones. This is especially common with milk, oils, and beverages, because it is difficult for consumers to detect the difference by sight or taste alone. By reducing the cost of production while presenting the product as genuine, offenders both defraud consumers and place fair-dealing businesses at a competitive disadvantage. Substitution is often part of a larger fraud, which blurs the line between adulteration and food fraud.

Food fraud, a broader and more complex issue, is any deliberate deception concerning food, undertaken for financial gain. Unlike traditional adulteration, food fraud does not always immediately alter the food itself, but it misleads both consumers and those who regulate food. A common example is mislabelling: giving incorrect or misleading information about the origin, composition, or quality of a product. A product may be falsely labelled as organic, high-quality, or from a particular place, exploiting consumers' confidence and their willingness to pay more.

Counterfeiting is another significant form of food fraud. This is the unlawful copying of branded food products, including their packaging, logos, and labels. Counterfeit products infringe intellectual property rights and pose a real danger to public health, because no one verifies their contents or the manner of their manufacture. The concealment of quality defects, by repackaging food past its use-by date or altering its appearance, further illustrates the deceptive nature of food fraud. Such acts are often facilitated by the complexity of modern food supply chains, in which many participants are involved, creating opportunities for manipulation and concealment.

Although food adulteration and fraud may be treated as distinct, in practice they are closely connected. Adulteration is chiefly concerned with the physical or chemical alteration of food, affecting its safety and quality, whereas food fraud is concerned with deceiving consumers and making money, and may not involve any contamination of the food. Many situations, however, involve both. Where a product is diluted and claimed to be pure, for example, it is both adulterated and fraudulent, and will accordingly attract more than one set of legal consequences.

The criminal dimension of these offences is particularly troubling because of the damage they can do to public health and to public trust in food. Consuming adulterated food can cause serious illness, produce long-term health problems, and, in the worst cases, lead to death. Beyond the harm to individuals, such conduct undermines confidence in the systems that are meant to keep food safe and calls the fairness of the market into question. Food crimes are therefore not mere breaches of regulation; they are serious offences affecting the health and safety of everyone.

Because these practices are concealed and constantly evolving, detecting them by ordinary methods is often insufficient. Simple inspection of food or standard testing may not reveal sophisticated adulteration or false information, especially where advanced techniques are used. It is here that food forensics becomes essential. It provides the scientific methods needed to detect hidden additives, confirm authenticity, and prove a link between the offence and the person who committed it. In other words, food forensics is vital to converting complex food violations into criminal cases that can be proved in court.

VI. FORENSIC TECHNIQUES USED IN FOOD ANALYSIS

The effectiveness of food forensics within the criminal justice system depends heavily on the science used to examine food. These scientific methods enable investigators to determine whether food has been adulterated, to prove that it is what it purports to be, and to connect the food item directly to the alleged offence. Unlike the ordinary testing conducted for food quality, forensic analysis must be highly accurate, reproducible, and carried out by reliable methods, because the findings will be presented in court as scientific proof. The methods chosen and the manner of their application must therefore meet accepted standards and withstand judicial scrutiny.

A major advance in food forensics is the use of DNA techniques, in particular DNA barcoding and genetic profiling. These are vital for identifying the true origin of food, especially where one food is substituted for another or is mislabelled. DNA testing can, for example, determine whether a meat product is in fact derived from the animal stated on the packaging, thereby revealing a fraudulent substitution. It can do the same for plant foods and can even detect genetically modified organisms where these are not permitted. DNA evidence is powerful because it is highly specific and dependable, making it an excellent means of establishing the facts in court.

Another important group of methods is chromatographic analysis, which is widely used to separate, identify, and measure the various chemical components of food. Gas chromatography and high-performance liquid chromatography are especially effective in detecting additives,

preservatives, toxins, and substances that ought not to be present. By separating compounds according to their chemistry, they enable forensic scientists to detect even minute quantities of unwanted substances. Where food has been tampered with by the addition of chemicals, chromatography often provides the principal proof of the presence of the harmful substance and of its quantity.

Closely related to chromatography is spectroscopic analysis, which ascertains the molecular structure and composition of a substance by examining how it interacts with light. Infrared spectroscopy, nuclear magnetic resonance, and mass spectrometry are all used in food forensics. These provide extensive detail about the chemical make-up of a food, assisting in the detection of contaminants, artificial additives, and deviations from the manner in which the food ought to be produced. Spectroscopic methods are valuable because they do not destroy the sample and yield rapid, accurate results, which is important where matters must be investigated quickly.

Alongside these, isotopic analysis is becoming increasingly important in determining the origin and authenticity of food. By examining the proportions of stable isotopes in a sample, forensic scientists can determine the environment and geographical location in which the food was grown or produced. This is particularly useful in cases where the origin of a food is falsely claimed, such as where a product is sold as coming from a particular area or as bearing a protected geographical indication. Isotope "fingerprints" provide strong proof in cases of misleading information.

Although each of these methods rests on different scientific principles, they are more effective when used together. Employing several methods to confirm the results makes the findings more dependable and credible. DNA analysis, for instance, can confirm the animal from which meat is derived, while chromatography and spectroscopy simultaneously detect any added chemicals. This combined approach is especially important in complex cases where a single method does not yield a definite answer.

From a legal standpoint, the extent to which these techniques may be used as evidence depends not only on their scientific soundness but also on the manner of their application. The collection, storage, transport, and analysis of a sample must follow strict rules in order to protect the integrity of the evidence. If the sample is contaminated, mishandled, or not analysed by standard methods, the results may be unreliable and the evidence inadmissible. Interpreting the analytical results also requires expert testimony, as courts need a qualified forensic scientist to explain the technical details in a manner that is readily understood.

Despite their benefits, forensic techniques for the analysis of food present difficulties. They are expensive, and they require specialised equipment and trained personnel, which means that they are not available everywhere, particularly in developing countries. Differences in the manner in which laboratories are run and in their methods can lead to differing results, giving rise to concerns about consistency and reliability. This underscores the importance of accredited laboratories, standardised procedures, and continuing training if forensic science is to be used effectively in food investigations.

In short, forensic techniques are the most important component of food forensics, converting scientific analysis into evidence that a court will accept. Because they can detect, identify, and confirm food-related crimes accurately, they are essential to the modern criminal justice system. As food fraud and tampering grow more sophisticated, the role of these advanced methods will become still more significant, strengthening the connection between science and law in the service of accountability and public health.

VII. EVIDENTIARY VALUE OF FOOD FORENSICS IN CRIMINAL JUSTICE

The use of food forensics within the criminal justice system has considerably improved the investigation and preparation of cases concerning adulterated or falsely sold food. Where a person is on trial for an offence, the prosecution must prove guilt to a very high degree of certainty, and science often becomes the most important element of that proof. Food forensics assists by offering impartial, verifiable proof, grounded in genuine scientific study, of matters such as the adulteration, contamination, or misdescription of food. Because this kind of forensic evidence derives from testing and the examination of facts, it is more trustworthy and more likely to persuade a court than ordinary evidence, which may depend on opinion or on the credibility of witnesses.

A. Nature of forensic evidence in food-related offences

Where something goes wrong with food and the matter reaches court, the principal proof is generally the laboratory report produced after scientists have examined the food. These laboratory reports establish whether a food item is safe and of the quality it ought to be, or whether it has been adulterated or misdescribed. Laboratory reports are valuable evidence because they provide figures and reproducible results, and those results prove directly what occurred. In many instances the law specifies precisely what defect in the food itself renders a product unlawful, so that testing of the food by a forensic scientist is essential to demonstrate that the law has been broken.

B. Admissibility of forensic evidence

Whether forensic evidence is admissible depends on well-defined rules. The evidence must be relevant to the case, reliable, and lawfully collected. Courts are particularly concerned with whether the analytical techniques have been scientifically validated and whether the tests were carried out by laboratories that are both reputable and accredited. The manner in which samples are gathered, kept safe, and recorded is equally crucial, because even a small error in the process could cast doubt on the authenticity of the evidence. Scientific correctness alone is therefore insufficient for evidence to be admitted; correct procedure in handling it is also vital.

C. Chain of custody and integrity of evidence

The chain of custody is of great importance in ensuring that forensic evidence is sound. It is a complete, written record of how a food sample is tracked, from the moment it is collected to the moment it is produced before a court. An unbroken record is necessary to prove that the sample tested by the laboratory is precisely the one originally taken, and that it has been neither altered nor contaminated in any way. Because even slight outside interference can affect test results in food cases, courts examine the chain of custody very closely. If the documentation is defective, or anything is missing, the evidence may be devalued and the court given good reason to doubt it.

D. Role of expert testimony

Because forensic analysis is highly technical, expert testimony explaining it in court is essential. These forensic experts, generally scientists or analysts, must describe the manner in which they carried out their work, what they found, and what those findings mean.³ They do more than present figures and details; they assist the court in grasping difficult scientific concepts and understanding them correctly. The persuasiveness of an expert's explanation depends on his or her credentials, experience, and impartiality, and this frequently shapes the court's view of the evidence to a significant degree.

E. Probative value in establishing guilt

Food forensics is valuable in court because it can establish precisely what matters about an offence. Science can prove that a prohibited substance has been added to food, that the food does not meet the required standards, or that it has been misdescribed, and this provides solid evidence for the prosecution. Such evidence is frequently the principal basis on which an accused person is found guilty, especially where there are no eyewitnesses or only indirect

³ See The Indian Evidence Act, 1872, No. 1, Acts of Parliament, 1872 (India), § 45 (opinions of experts); now The Bharatiya Sakshya Adhinyam, 2023, No. 47, Acts of Parliament, 2023 (India), § 39.

indications of what occurred. Being grounded in fact, it lends greater clarity and improves the prospect of a fair and correct decision.

F. Limitations and evidentiary challenges

Important though it is, forensic evidence in food cases is not without limitations. The manner in which samples are handled, the lack of consistent methods of testing, and delays in laboratory work can all diminish the reliability of the results. Divergent practices among laboratories, or disagreement among experts, can generate doubt, and that doubt may be exploited in court. Courts are therefore careful in assessing forensic evidence, judging both the soundness of the science and the surrounding circumstances. These difficulties highlight the need for standardised procedures, official accreditation of laboratories, and a continuing effort to improve the manner in which forensics is conducted.

G. Evidentiary significance in modern criminal justice

Modern criminal justice systems increasingly rely on scientific proof in order to be just, accurate, and impartial in their decisions. Food forensics accords with this broader change because it offers a robust means of adducing evidence capable of addressing complex crimes involving new technology. Courts accept it increasingly because they recognise that scientific testing enhances the credibility of legal cases and strengthens the justice system. As food-related crimes grow more complex, food forensics is likely to become even more important to securing accountability and protecting the public.

VIII. LEGAL FRAMEWORK GOVERNING FOOD ADULTERATION

India's laws on food adulteration are carefully constructed, drawing on both regulatory and criminal law in order to protect public health and to hold offenders accountable. The shift from numerous separate food laws to a single system administered by the Food Safety and Standards Authority of India under the Food Safety and Standards Act, 2006 was a significant advance.⁴ This Act is grounded in science, sets safety standards for food, and relies heavily on laboratory testing to determine whether foods meet those standards; the courts have repeatedly held that such scientific proof is essential to establishing food adulteration.

The courts have held on many occasions that the adulteration of food is not a minor technicality but a serious danger to public health. In *Municipal Corporation of Delhi v. Kacheroo Mal*, the Supreme Court made clear that food adulteration is a grave social problem that must be dealt

⁴ The Food Safety and Standards Act, 2006, § 4, No. 34, Acts of Parliament, 2006 (India) (establishing the Food Safety and Standards Authority of India).

with severely.⁵ It observed that even a small degree of tampering with food can cause considerable harm to the health of many people, and that it must accordingly be treated firmly. This case demonstrates the courts' understanding of food adulteration as a problem affecting society at large, rather than a mere breach of regulation.

The courts have also repeatedly emphasised the importance of following all the correct procedures, particularly in the collection and testing of food. In *State of Kerala v. Alasserry Mohammed*, the Supreme Court held that prosecutors must adhere to the rules for taking and testing food samples.⁶ Any lapse in complying with the law could undermine the case, because the proof would not be trustworthy. This underscores the importance of correct procedure in ensuring that laboratory results can be used as evidence.

Municipal Corporation of Delhi v. Ghisa Ram concerned the time taken to test food samples.⁷ The Court observed that where testing is delayed unduly, the sample itself may deteriorate and prejudice the accused, especially where the food is perishable. Testing must be carried out promptly in fairness to all parties and in order to ensure that the laboratory results are reliable. This shows that procedural errors can affect both the admissibility and the value of scientific evidence in court.

Recourse to the criminal provisions of the Indian Penal Code adds to the seriousness of food-related offences.⁸ The courts have held that where adulteration renders food dangerous or poisonous, it may attract punishment under the Penal Code in addition to the ordinary food-safety regulations. In such cases the conduct is regarded as a threat to public safety and is examined by the court with particular care. The Food Safety and Standards Act and the Indian Penal Code operate together to ensure that such conduct is treated both as a breach of regulation and as a crime against public health.

As regards laboratory reports, the courts generally accept them as expert evidence, but only where correct procedure has been followed and the testing has been properly conducted. Judges have, however, cautioned against accepting a report automatically without examining the manner in which it was obtained. The admissibility and weight of forensic evidence depend on the competence of the laboratory, the use of appropriate methods, and the existence of other evidence supporting the report.

⁵ *Municipal Corporation of Delhi v. Kacheroo Mal*, AIR 1976 SC 394 (India).

⁶ *State of Kerala v. Alasserry Mohammed*, AIR 1978 SC 933 (India).

⁷ *Municipal Corporation of Delhi v. Ghisa Ram*, AIR 1967 SC 970 (India).

⁸ The Indian Penal Code, 1860, *supra* note 2, §§ 272–273 (adulteration of food or drink intended for sale; sale of noxious food or drink).

All of these decisions demonstrate that the effectiveness of the food-safety laws depends on combining forensic science with correct legal procedure. The laws themselves provide the foundation for regulation and punishment, but the quality of the evidence, and in particular the scientific evidence, is what ultimately determines whether a prosecution will succeed. The courts have consistently held that both the substantive law and adherence to correct procedure are required to ensure that justice is done and is seen to be done.

At the same time, these cases point to certain problems in the system, such as delays in testing, inconsistency in the manner in which procedures are carried out, and weaknesses in enforcement. These problems reveal a need to improve forensic laboratories, to standardise the manner of testing, and to analyse samples promptly and accurately. Unless these issues are addressed, the laws will not operate as effectively as they should.

In short, India's system for dealing with food adulteration is well conceived, combining regulation with criminal penalties and supported by the courts' interpretation of the law. Its practical effectiveness, however, depends on the law, procedure, and forensic science operating seamlessly together. As the courts have emphasised, the inclusion of scientific evidence in legal cases is crucial to holding offenders accountable and to protecting public health.

IX. CHALLENGES IN THE USE OF FOOD FORENSIC EVIDENCE

Food forensics is now crucial to the investigation and prosecution of adulterated or fraudulent food. Even so, its use in criminal cases continues to encounter numerous procedural, legal, and evidentiary difficulties. Forensic science depends not only on the quality of the laboratory tests but also on the legal setting and the institutions responsible for ensuring that the evidence is accurate, kept safe, and presented in court. In food cases, where the food itself may spoil, be readily altered, or have a complex composition, even small procedural errors can significantly change the outcome. The credibility a court attributes to a food-forensics report is therefore often judged not only by the science but also by the rigour of the legal procedures surrounding it.

One of the most persistent difficulties is that testing standards and laboratory practices are not uniform. The analysis of food requires highly specific methods, and the reliability of the results depends on the laboratory's use of validated processes, accurately calibrated instruments, and a consistent approach to interpreting the findings. In practice, however, results may vary because of differences in equipment, expertise, and methods between laboratories. This is especially problematic where the prosecution relies heavily on a single forensic report to prove that food has been altered or is fraudulent. If the defence can show that the testing was not conducted

consistently or was insufficiently standardised, the evidentiary value of the report may be diminished. Standardised procedures are therefore essential if forensic reports are to be trusted in court.

A further significant problem concerns the collection and safe-keeping of samples, that is, the chain of custody. Food samples must be gathered, sealed, labelled, transported, and examined in a manner that removes any suspicion of tampering or contamination. Although this ought to be straightforward, it is frequently where errors occur. Delays in delivering the sample to the laboratory, improper storage, incomplete records, or broken seals can all render the sample unreliable. Food may also degrade over time, particularly in hot or humid conditions, and any error in handling can alter its composition. Courts are understandably cautious in such circumstances; a broken chain of custody can create reasonable doubt as to whether the sample analysed is the one originally taken.

The perishability of food gives rise to further difficulty. Unlike much other forensic evidence, food changes chemically, biologically, or physically relatively quickly. Loss of moisture, microbial growth, decomposition, and contamination after seizure can all affect the results of analysis. This creates a distinctive evidentiary problem: by the time the food reaches the laboratory, it may no longer be in the same condition as when it was taken. The law rightly stresses the importance of prompt analysis and proper preservation, but acting quickly is difficult for hard-pressed enforcement agencies. Where analysis is delayed, the defence may argue that the results do not reflect the actual state of the food at the time of the offence.

A shortage of skilled staff and of up-to-date facilities is a further significant limitation. Food forensics is a highly technical field requiring knowledge of both laboratory science and the legal requirements for evidence. In many areas, and especially in developing countries, laboratories lack sufficient staff, adequate funding, and modern equipment. This can cause backlogs, delayed reports, and occasional errors. The issue is not merely one of paperwork or administration; it bears directly on the ability of prosecutors to win their cases. Food-tampering cases collapse where the forensics are weak, not because the offence did not occur, but because the evidence is not strong enough or is not available quickly enough.

The admissibility of expert evidence and the manner in which judges assess it also present difficulties. Courts do not automatically accept scientific reports as conclusive. They determine instead whether the evidence is relevant, whether the laboratory's methods are sound, whether the sample was free from interference, and whether the expert has explained his or her opinion adequately. Because of the technical nature of the report, the court may sometimes struggle to

understand its meaning without a clear and skilled explanation from the expert. If the expert cannot readily relate the scientific results to the actual legal questions, the report will be less persuasive as evidence. In prosecutions relating to food, expert witnesses are therefore particularly important.

A further practical problem is the difference between enforcing regulations and instituting a criminal case. Food-safety authorities can inspect, take samples, and issue warnings, but a criminal case requires far more solid proof. Conduct that begins as a regulatory breach may fail in court if the investigation does not reach the standard of proof a criminal trial requires. The detection of a problem through routine checks does not necessarily mean that it can be proved in court. As a result, some wrongdoers may receive only a regulatory penalty and escape criminal conviction, even where the health of many people has been put at risk. Addressing this requires food inspectors, laboratories, lawyers, and courts to work together more effectively.

The problem of inadequate resources and of the time matters take must also be addressed. From the moment a food item is taken as evidence, many months may elapse before it is finally analysed, and longer still before the trial concludes. Such delays diminish the usefulness of forensic evidence, particularly where the accused contends that the sample is not genuine or that correct procedure was not followed. Justice depends on being both accurate and timely. Where reports are late, or the chain of evidence is not carefully recorded, the court may lack the confidence to rely on the results. This is especially serious with food that poses a risk to public health, since a delay in justice weakens both the deterrence of the offence and the accountability of offenders.

Finally, the degree of public trust in official bodies, and their perceived reliability, must be considered. Forensic evidence commands respect only where the institutions that produce it are seen as competent, impartial, and dependable. If laboratories are regarded as inconsistent, slow, or prone to operational error, the entire system of enforcement is damaged. Strengthening food forensics is therefore not merely a technical adjustment; it is a matter of public confidence in institutions. The courts must be able to demonstrate that their scientific evidence is both correctly produced and procedurally fair.

In short, the use of food forensic evidence in criminal trials can be very powerful but is also easily undermined. Its strength lies in its grounding in fact, but its weaknesses arise from procedural errors, institutional limitations, and the manner in which judges assess it. These difficulties do not diminish the importance of food forensics; rather, they show why it requires more consistent standards, improved facilities, and a much closer relationship between science

and law. Unless these concerns are addressed, the potential of food forensics as evidence will be only partly realised.

X. NEED FOR REFORM AND STRENGTHENING MECHANISMS

Because of the problems attending the use of forensic evidence in food cases, a comprehensive overhaul of the enforcement of food laws is urgently needed, improving both the scientific and the legal aspects. India has good laws and an increasing number of laboratories, but what truly matters is how well those laws and laboratories work together. This reform is not merely a matter of amending the laws; it is a broader effort to make forensic science in court more trustworthy, faster, and more credible.

A key priority is the standardisation of forensic methods and of laboratory practice. At present, different laboratories use different testing processes and approaches to interpreting the results, which leads to conflicting findings and weakens the value of forensic reports. A single set of standard procedures, validated testing methods, and clear guidelines for interpreting results is needed to ensure that the same analysis produces the same outcome wherever it is conducted. Laboratory accreditation and regular quality checks would further enhance confidence in the findings and reduce disputes in court.

Strengthening the forensic infrastructure and the available technology is equally vital. Food forensics depends heavily on sophisticated equipment and properly trained personnel, both of which require continuing investment. Increasing the number of accredited laboratories, improving existing facilities, and ensuring the availability of modern analytical tools would reduce delays and improve accuracy. Scientists, food analysts, and law-enforcement officers must also be trained to keep pace with the latest methods of detecting food fraud. Without such investment, the gap between what the law expects and what is actually achievable will remain.

Another important change is the integration of the investigative and regulatory functions. At present, food-safety enforcement is often fragmented, with little communication between inspectors, laboratories, and prosecutors. This can cause procedural errors, incomplete records, and a break in the chain of evidence. A more unified approach, in which regulators, forensic scientists, and lawyers work together from the outset of an investigation, would improve the quality of the evidence and make successful prosecutions more likely. The Food Safety and Standards Authority of India has a significant part to play in this coordination, by providing guidance, training, and oversight.

The laws themselves could also be improved as regards the time matters may take and the evidence required. Because food is perishable, delays in testing can seriously undermine the

reliability of samples. Setting firmer deadlines for testing, reporting, and instituting prosecutions would help to preserve the evidence and secure justice promptly. Clearer laws on the admissibility and weight of forensic evidence would also reduce uncertainty and make judicial decisions more consistent.

The manner in which experts give evidence, and the degree to which judges understand the science, must also be improved. Courts rely on expert opinions where the evidence is technical, but those opinions are useful only if the experts can explain complex findings in a clear and impartial manner. Training forensic experts in legal procedure, and educating judges and lawyers in scientific principles, would bridge the gap between technical knowledge and legal interpretation, enabling the courts to assess forensic evidence properly and reducing the risk of misunderstanding.

Reform must also make forensic institutions accountable and transparent. Peer review, independent confirmation of results, and careful record-keeping of procedures would all enhance the credibility of forensic reports. Where errors or inconsistencies occur, there should be clear mechanisms for review and correction, so that justice is not compromised. Transparency about the operation of laboratories and their reporting standards would further build public confidence.

Finally, there is an increasing need to prevent food-safety problems and to use technology to that end. Digital tracking systems, blockchain-based monitoring of the supply chain, and real-time testing can be used alongside traditional forensic methods to identify fraud and contamination at an early stage. Such advances not only make enforcement more efficient but also deter offending in the first place, because offenders are more likely to be caught.

In short, strengthening food forensics within the criminal justice system requires a comprehensive approach involving legal reform, institutional improvement, the adoption of technology, and closer cooperation between agencies. The goal is not merely to secure more convictions but to ensure that the system delivers results that are accurate, prompt, and fair. By addressing these issues, the full potential of food forensics can be harnessed to protect public health and to uphold the law.

XI. COMPARATIVE PERSPECTIVE ON FOOD FORENSICS AND LEGAL ENFORCEMENT

Examining how food forensics is practised in different jurisdictions shows that the underlying science for detecting adulterated or falsely labelled food is much the same everywhere. The laws in force, the degree to which institutions cooperate, and the manner in which evidence is

presented in court, however, differ considerably. These differences have a real bearing on how effectively forensic proof is produced, preserved, and then used in prosecutions for food crimes. Comparing these systems is not merely a matter of listing what occurs in each; it reveals where matters are working well and where they are not, and this determines whether food forensics is a powerful instrument of justice or something the courts do not use to its full capacity.

A. United States: risk-based regulation and forensic integration

In the United States, the Food and Drug Administration is chiefly responsible for food safety, and the Department of Agriculture assists in relation to particular parts of the food industry. The Food Safety Modernization Act has significantly changed matters; instead of dealing only with problems after they occur, the focus is now on preventing them through a system of risk-based rules.⁹ As a result, forensic science in food safety is no longer confined to establishing what went wrong after someone falls ill; it now forms part of monitoring for problems, keeping matters under observation, and detecting outbreaks of illness. Laboratories in the Food Emergency Response Network enable rapid, consistent testing across different regions. Forensic information is thus continually produced, shared, and confirmed as accurate.

As regards court and evidence, the American legal system seeks to ensure that expert opinions rest on sound science. The Daubert test is one of the rules to this end, ensuring that forensic techniques presented in court are both relevant to the case and properly validated by scientists and reviewed by other experts.¹⁰ DNA analysis, chromatography results, and detailed chemical analysis are accordingly accepted as important evidence, provided they are regarded as trustworthy.

One of the strengths of the American approach is the manner in which forensic information and enforcement are linked. Investigations to identify the source of contamination, tracing food through its journey, depend heavily on forensic information. This enables the authorities to demonstrate that food was adulterated, to show how the problem arose, and to establish who is responsible, all of which is essential to a criminal prosecution.

B. European Union: traceability and the precautionary principle

The European Union, through the European Food Safety Authority, is highly structured and cautious in matters of food safety. The Union's General Food Law establishes a comprehensive

⁹ FDA Food Safety Modernization Act, Pub. L. No. 111-353, 124 Stat. 3885 (2011).

¹⁰ Daubert v. Merrell Dow Pharmaceuticals, Inc., 509 U.S. 579 (1993).

system built on the traceability of the journey of food, transparency, and the assessment of risk, which greatly assists in building a strong case for food forensics.¹¹

A key element of the Union's system is the rule requiring all food businesses to know where their food has been at every stage of its production and sale. This creates a documentary trail that operates alongside forensic investigations, enabling investigators to link the scientific findings to the movement of the food through the supply chain. Forensic proof is therefore not usually adduced in isolation; it is supported by records and sales information, which makes it much more likely to be believed.

The Union has a large number of reference laboratories that use the same testing methods in each country. This ensures that results do not vary greatly and that forensic findings are both reliable and admissible. Under the precautionary principle, moreover, regulators may take steps to address a problem even where they are not entirely certain of the science. This is done to protect consumers, even where it means acting without wholly conclusive proof.

As regards the handling of crimes, this approach means that forensic proof is not the only requirement. Regulations may be enforced on the basis of the risk that something is wrong, with science providing indications. Where a prosecution ensues, however, the combination of the record of the food's journey and forensic testing provides a very solid evidentiary foundation.

C. United Kingdom: intelligence-led enforcement and forensic response

The Food Standards Agency in the United Kingdom polices food through a system built on carefully collected intelligence and on the detailed scientific examination of food. The approach in this area has been strongly influenced by several highly public cases of food dishonesty, most famously the discovery of horsemeat in products supposed to be wholly beef, which revealed significant weaknesses in the supply chain.

In response, the United Kingdom substantially strengthened its National Food Crime Unit. The Unit operates much like a department investigating serious crime, but in relation to grave food offences.¹² This reflects the United Kingdom's recognition that food fraud can be a form of organised crime and must therefore be investigated in a manner similar to other financial crimes.

In the United Kingdom, forensic science and the gathering of intelligence are closely linked. DNA tests, isotope analysis, and examination of the chemical composition of foods are regularly used to determine whether one product has been substituted for another, or to confirm that a

¹¹ Regulation 178/2002, of the European Parliament and of the Council of 28 January 2002 Laying Down the General Principles and Requirements of Food Law, Establishing the European Food Safety Authority and Laying Down Procedures in Matters of Food Safety, 2002 O.J. (L 31) 1.

¹² See Chris Elliott, *Elliott Review into the Integrity and Assurance of Food Supply Networks: Final Report* (2014).

product is what it is labelled as. The results of these forensic tests are used alongside surveillance, financial information, and a review of the entire route the food takes to the consumer, building up a substantial body of evidence.

The United Kingdom system also relies on the opinions of experts and on their effective presentation of evidence in court. The science is explained in a straightforward manner and is shown to be relevant to the law. This reduces the risk of misunderstanding and ensures that forensic reports are given considerable weight during proceedings.

D. India in comparative context: structural strengths and gaps

India's food-safety system, administered by the Food Safety and Standards Authority of India, has strong laws but does not operate in practice as effectively as it should. The law provides for the scientific testing of food, for governmental oversight, and for the imprisonment of offenders, yet these elements do not fit together as smoothly as they do in the jurisdictions already examined.

A significant problem is that enforcement generally occurs after something is suspected, and forensic investigations are conducted at that point. They do not form part of a system of continuous monitoring, such as those maintained in the United States and the European Union. Because India lacks a fully functioning system for real-time tracking and observation, preventing problems through enforcement is more difficult.

Food-testing laboratories are also not all held to the same standards and are stretched too thin. This affects the dependability and consistency of forensic work. Accredited laboratories exist, but their distribution, resources, and technology are uneven across the country. This lengthens investigations, and the evidence in a laboratory report is sometimes not strong enough to be used in court.

Finally, the connection between regulatory action and criminal prosecution is not always effective. Problems are identified by the authorities but often do not result in successful criminal prosecutions, owing to procedural errors, poor record-keeping, or the absence of a sound chain of evidence. This contrasts with the United Kingdom, where investigators and prosecutors work much more closely together.

XII. CONCLUSION AND SUGGESTIONS

Food adulteration and fraud, once matters for regulators to handle, are now serious criminal concerns. This article has shown how food forensics is central to connecting scientific findings to the proof a court requires, enabling the authorities to identify precisely what is wrong and

then to offer solid proof in court. As food supply grows more complex and profit-driven crimes become more sophisticated, the use of science is now essential to securing accountability and protecting the public.

Considering the forensic methods themselves, current techniques such as DNA profiling, chromatography, spectroscopy, and isotopic analysis are highly accurate both in detecting adulterants and in confirming authenticity. That accuracy does not, however, guarantee admissibility; admissibility depends on following correct procedure, on standardisation, and on presenting the information to the court correctly. The courts have repeatedly held that even the best scientific evidence becomes worthless if the samples were not taken correctly, if the chain of custody was broken, or if the legal rules were not observed. Food forensics is therefore powerful not because of the science alone; it must also fit with what the law requires.

Turning to the law in India, the framework, with the Food Safety and Standards Authority of India at its centre and criminal provisions in the Indian Penal Code in support, is fairly comprehensive. In practice, however, it often does not operate as effectively as it should, owing to inadequate facilities, divergent laboratory practices, slow testing, and a lack of cooperation between regulators and prosecutors. The United States, the European Union, and the United Kingdom have been more successful through standardised practices, the integration of enforcement, and a preventive approach that uses technology and the traceability of food through the system.

It is therefore clear that strengthening food forensics within the criminal justice system requires action on several fronts at once. This means reforming the law, improving the capacity of institutions, and advancing the science. The goal is not merely to secure more convictions but to build a system that delivers reliable, prompt, and just results, which in turn will enhance public confidence in it.

The following suggestions are offered.

- Establish uniform and standardised forensic testing protocols across all laboratories to ensure the consistency, reliability, and admissibility of scientific evidence in court.
- Expand and upgrade forensic laboratory infrastructure with advanced analytical equipment, and increase the number of accredited laboratories, in order to reduce delays and improve accuracy.
- Provide continuous professional training for food analysts, forensic experts, enforcement officers, and prosecutors, so as to enhance technical competence and procedural compliance.

- Implement strict, and preferably digital, chain-of-custody systems for the proper documentation of sample collection, sealing, storage, and transportation, in order to prevent tampering and maintain evidentiary integrity.
- Strengthen coordination between regulatory authorities such as the Food Safety and Standards Authority of India, investigative agencies, and prosecution bodies, to ensure effective case development and successful conviction.
- Introduce clear procedural reforms, including statutory timelines for sample testing and reporting, to avoid delays and preserve the reliability of evidence.
- Ensure stricter enforcement of the penal provisions under the Indian Penal Code and the food-safety laws, especially in cases involving serious public-health risks.
- Adopt advanced technological solutions such as blockchain-based traceability systems, digital supply-chain monitoring, and real-time testing tools to improve the detection and prevention of food fraud.
- Enhance the quality of expert testimony by training forensic professionals in legal procedure and in the effective courtroom communication of scientific findings.
- Promote judicial awareness and understanding of forensic science through training programmes for judges and legal practitioners, in order to improve the evaluation of scientific evidence.
- Establish mechanisms for transparency and accountability in forensic laboratories, including regular audits, peer review, and the independent verification of results.
- Create specialised units or task forces dedicated to investigating food adulteration and fraud, particularly in cases involving organised or large-scale offences.
