Food Adulteration through Mislabelling of Genetically Modified Ingredients: A Comparative Analysis of India, The European Union and The United States

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Abstract

The globalization of food markets and the rapid advancement of biotechnology have significantly transformed food production systems worldwide. Genetically modified organisms (GMOs), particularly genetically modified crops, have become central to debates concerning food safety, consumer rights, environmental sustainability, and international trade. One of the most controversial issues surrounding genetically modified food is the mislabelling or non-disclosure of genetically modified ingredients in food products. Such practices may constitute a modern form of food adulteration because consumers are deprived of accurate information regarding the nature and composition of the food they consume.

This article examines the issue of food adulteration through the mislabelling of genetically modified ingredients by comparatively analyzing the legal and regulatory frameworks of India, the European Union (EU), and the United States (USA). The study explores the concept of GMO-related adulteration, legal obligations concerning labeling and traceability, enforcement mechanisms, consumer protection concerns, and policy differences among the three jurisdictions. The article concludes that while the EU has developed the most comprehensive and transparent GMO labelling system, the USA adopts a comparatively flexible market-oriented approach, whereas India remains in a transitional regulatory phase characterized by precautionary policies but limited enforcement capacity.

Keywords

Food, Adulteration, Genetically Modified Organisms, Mislabelling, Bioengineered, Safety, Genetic Engineering, Misbranding, European Union, Regulation

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Introduction

Food adulteration has historically referred to the intentional degradation of food quality through substitution, contamination, dilution, or addition of inferior substances for economic gain. In the contemporary regulatory environment, however, adulteration has expanded beyond physical contamination to include informational adulteration, particularly through misleading food labels and false declarations regarding genetically modified ingredients.

Genetically modified organisms are organisms whose genetic material has been artificially altered using biotechnology techniques to achieve desired characteristics such as pest resistance, enhanced nutrition, or increased crop yield. Although proponents argue that GM foods improve agricultural productivity and food security, critics raise concerns relating to human health, environmental risks, biodiversity loss, corporate monopolization of agriculture, and ethical issues.

A major concern in international food regulation is the mislabelling of GM ingredients. Consumers may unknowingly consume genetically modified products because of false "non-GMO" claims, incomplete disclosure, or absence of mandatory labelling requirements. Such practices undermine the consumer's right to informed choice and may constitute deceptive trade practices and food fraud.

Different jurisdictions have responded differently to GMO labelling issues. The European Union adopts a strict precautionary and consumer-cantered regulatory approach emphasizing mandatory disclosure and traceability. The United States historically favoured voluntary labelling and biotechnology innovation but later introduced mandatory bioengineered food disclosure requirements. India follows a cautious regulatory model with restrictive approvals for GM foods but still faces significant implementation challenges.

This article comparatively evaluates these legal frameworks and analyses how mislabelling of genetically modified ingredients constitutes a modern form of food adulteration.

Concept of Food Adulteration through GMO Mislabelling

Meaning of GMO Mislabelling

Food adulteration through GMO mislabelling refers to the deceptive practice of providing false or misleading information about the presence of genetically modified organisms (GMOs) in food products. GMOs are organisms whose genetic material has been altered using biotechnology to obtain desirable characteristics such as higher yield, pest resistance, or improved shelf life. Mislabelling occurs when food products containing GMO ingredients are falsely advertised as "Non-

GMO," "Organic," or completely free from genetically modified substances. It may also involve failing to disclose GMO content where labeling is legally required. This practice is considered a form of food adulteration because it hides the true composition and quality of the product, thereby misleading consumers.

GMO mislabelling creates several concerns related to consumer rights, health, ethics, and economics. Consumers who prefer non-GMO foods for health, environmental, religious, or ethical reasons are unable to make informed choices when labels are inaccurate. In many cases, non-GMO products are sold at higher prices, so false labeling also amounts to economic fraud. Although many genetically modified foods are approved as safe, some consumers remain concerned about possible allergic reactions or long-term health effects. Incorrect labeling can therefore reduce public trust in food manufacturers and regulatory authorities.

To prevent such adulteration, governments and food safety organizations have introduced regulations for proper GMO labeling and food testing. In India, the Food Safety and Standards Authority of India oversees food labeling standards and can take action against misleading claims. Measures such as laboratory testing, transparent supply chains, strict inspections, and consumer awareness programs help ensure that food products are accurately labeled. Therefore, GMO mislabelling is not only a legal issue but also an important matter of consumer protection and food ethics.

Types of GMO-Related Misrepresentation

There are several types of GMO-related misrepresentation that can occur in the food industry. One common type is false "Non-GMO" labeling, where products containing genetically modified ingredients are deliberately marketed as free from GMOs in order to attract health-conscious consumers and charge higher prices. Another type is omission of GMO information, in which manufacturers fail to disclose the presence of genetically modified ingredients even when regulations require such disclosure. This prevents consumers from making informed decisions about the food they purchase.

Another form of misrepresentation involves misleading organic claims, where foods produced using genetically modified crops are falsely labeled as "organic" or "natural." Since organic standards in many countries prohibit the use of GMOs, such labeling deceives consumers and violates food regulations. Import-related misrepresentation is also common, especially when imported processed foods containing GMO ingredients are sold without proper labeling to bypass national laws or inspections. In some cases, companies may provide inaccurate percentages of GMO content, understating the actual amount present in the product.

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Cross-contamination misrepresentation is another issue, where manufacturers claim a product is GMO-free even though it has been contaminated with GMO material during processing, transportation, or storage. Additionally, fraudulent certification may occur when fake or unauthorized "Non-GMO certified" labels are placed on packaging to create false consumer confidence. These forms of GMO-related misrepresentation are considered deceptive practices because they conceal the true nature of food products, mislead consumers, and undermine food safety and labeling regulations.

Misleading organic or natural claims are also common forms of GMO misrepresentation. Organic foods are generally expected to be free from genetically modified ingredients. However, some products falsely use labels such as "organic," "100% natural," or "farm fresh" despite containing GMO components. These claims are designed to create a healthier image of the product and increase sales. Consumers who purchase such products believing they are free from genetic modification are therefore misled.

Import-related GMO misrepresentation occurs when imported food products containing GMO ingredients enter a country without proper declaration or labeling. Some exporters intentionally avoid mentioning GMO content to bypass strict import regulations or customs checks. As a result, consumers may unknowingly purchase and consume genetically modified foods. This problem is especially significant in countries with strict GMO policies and limited inspection facilities.

Overall, GMO-related misrepresentation involves many deceptive practices that hide the true nature of food products. These practices can lead to consumer deception, economic fraud, loss of public trust, and violations of food safety laws. Therefore, strict regulations, scientific testing, transparent labeling, and consumer awareness are necessary to prevent GMO-related food adulteration and ensure honesty in the food industry.

Regulatory Framework for GMO Foods in India

The regulatory framework for genetically modified organisms (GMOs) in India is designed to ensure food safety, environmental protection, and proper labeling of genetically modified food products. The regulation of GMOs involves several government bodies, laws, and guidelines that monitor the development, import, manufacture, storage, sale, and use of genetically modified foods and crops. The framework aims to protect consumers from unsafe products and prevent misleading practices such as GMO mislabelling.

Regulatory Framework in India: Historical Development

The regulatory framework for genetically modified organisms (GMOs) in India has developed gradually in response to advancements in biotechnology, concerns

about food safety, and the need to protect the environment and public health. India began focusing on biotechnology regulation during the 1980s when genetic engineering research started expanding in agriculture and food production. To manage the possible risks associated with genetically engineered organisms, the government introduced legal and institutional mechanisms for biosafety and regulation.

A major milestone in the historical development of GMO regulation was the enactment of the Environment (Protection) Act, 1986[1]. This Act provided the central government with broad powers to protect and improve environmental quality and became the legal foundation for regulating genetically engineered organisms in India. Under this Act, the government introduced the Rules for the Manufacture, Use, Import, Export, and Storage of Hazardous Microorganisms/Genetically Engineered Organisms or Cells, 1989[2]. These rules were the first specific regulations dealing with genetically modified organisms and biosafety in the country. They established procedures for approval, monitoring, and risk assessment of GMO-related activities.

In recent years, India has focused more on GMO labeling, import control, and biosafety testing. Regulations have been updated to address concerns about GMO mislabelling, unauthorized imports, and consumer awareness. The government has also faced debates and public protests regarding the approval of certain GM crops such as Bt Brinjal and GM Mustard, reflecting the social, ethical, and environmental dimensions of biotechnology regulation in India.

Overall, the historical development of India's GMO regulatory framework shows a gradual shift from basic environmental protection measures to a more comprehensive system involving biosafety assessment, food regulation, consumer protection, and scientific monitoring. The framework continues to evolve as biotechnology advances and new challenges emerge in the field of genetically modified foods and crops.

Statutory Framework: Food Safety and Standards Act, 2006

The Food Safety and Standards Act, 2006 is the primary legislation governing food safety and regulation in India. It was enacted to consolidate various food laws and establish a comprehensive legal framework for ensuring the availability of safe and wholesome food for consumers. Before this Act, food regulation in India was governed by multiple laws and orders, which created confusion and overlapping responsibilities among authorities. The Food Safety and Standards Act, 2006 (FSS Act) was therefore introduced to create a single unified system for food regulation, including matters related to genetically modified foods and food adulteration.

The Act led to the establishment of the Food Safety and Standards Authority of India, which serves as the central regulatory authority responsible for laying

down science-based standards for food products and regulating their manufacture, storage, distribution, sale, and import[3]. FSSAI operates under the Ministry of Health and Family Welfare and plays a major role in monitoring food safety, labeling requirements, and consumer protection in India.

One of the important objectives of the Act is to prevent food adulteration and misleading practices. Under the Act, any food product that is unsafe, substandard, falsely labeled, or misbranded may attract penalties and legal action[4]. This provision is highly relevant in cases of GMO mislabelling, where genetically modified food products may be falsely sold as "Non-GMO" or "organic." Such misleading claims are treated as violations of food labeling and consumer protection standards.

The Act also empowers FSSAI to regulate imported food products and ensure that they comply with Indian safety standards[5]. Imported food items suspected of containing genetically modified ingredients may be tested, inspected, or rejected if they fail to meet regulatory requirements. Through this authority, the government seeks to prevent unauthorized or unsafe GM foods from entering the Indian market. Another significant aspect of the Food Safety and Standards Act, 2006 is its emphasis on proper labeling and transparency. Food businesses are required to provide accurate information regarding ingredients, additives, nutritional value, and other relevant details on product packaging[6]. This helps consumers make informed choices and reduces the risk of deception. In the context of GMO foods, labeling regulations are particularly important because many consumers prefer to know whether a product contains genetically modified ingredients for health, ethical, environmental, or religious reasons.

The Act further provides mechanisms for food testing, inspections, licensing, and enforcement. Food Safety Officers are empowered to collect food samples, conduct investigations, and take action against violators[7]. Penalties under the Act may include fines, suspension of licenses, product recalls, and imprisonment in serious cases involving unsafe food. These enforcement measures strengthen the regulatory framework against food adulteration and GMO-related misrepresentation.

Overall, the Food Safety and Standards Act, 2006 forms the backbone of India's food regulatory system. It plays a vital role in ensuring food safety, preventing adulteration, regulating genetically modified food products, and protecting consumer interests. By establishing FSSAI and creating uniform food standards, the Act has significantly improved the legal and institutional framework for food regulation in India.

Environment (Protection) Act, 1986

The Environment (Protection) Act, 1986 is one of the most important environmental laws in India and serves as the foundational legislation for regulating

genetically modified organisms (GMOs) and biosafety in the country. The Act was enacted by the Government of India after the Bhopal Gas Tragedy to provide a comprehensive framework for the protection and improvement of the environment and to prevent hazards to human beings, animals, plants, and property[8]. It grants broad powers to the Central Government to take measures necessary for environmental protection and pollution control.

The Environment (Protection) Act, 1986 plays a crucial role in the regulation of biotechnology and genetically engineered organisms. Under Section 6, Section 8, and Section 25 of the Act, the government framed the Rules for the Manufacture, Use, Import, Export and Storage of Hazardous Microorganisms/Genetically Engineered Organisms or Cells, 1989[9]. These rules specifically deal with the safe handling, research, testing, transport, production, and environmental release of genetically modified organisms. They form the legal basis for India's biosafety and GMO regulatory system.

The Act empowers the Central Government to regulate industries, processes, and activities that may pose risks to the environment or public health[10]. Since genetically modified organisms may have ecological and health implications, their research and commercial use are closely monitored under this legislation. The government may issue directions, impose restrictions, or prohibit certain activities involving genetically engineered products if they are considered harmful to the environment or biodiversity.

Under the framework created by the Environment (Protection) Act, several regulatory bodies have been established to supervise GMO-related activities. The Genetic Engineering Appraisal Committee functions as the apex authority responsible for granting approvals for large-scale use, environmental release, and import of genetically modified organisms[11]. Similarly, the Review Committee on Genetic Manipulation supervises laboratory research and field trials involving GMOs. Institutional Biosafety Committees (IBSCs) and State Biotechnology Coordination Committees (SBCCs) also function under the regulatory mechanism established through the Act and related rules.

In the context of GMO mislabelling and food adulteration, the Act indirectly contributes to consumer protection by ensuring that genetically modified organisms are properly regulated before entering the food chain. Environmental risk assessments, biosafety testing, and approval procedures help minimize the risks associated with genetically engineered products. The Act therefore acts as a cornerstone of India's GMO regulatory framework by combining environmental protection with scientific oversight and public safety.

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Overall, the Environment (Protection) Act, 1986 provides the legal and institutional foundation for regulating genetically modified organisms in India. Through its broad environmental powers and biosafety rules, it supports sustainable development, protects biodiversity, and ensures that biotechnology activities are carried out responsibly and safely.

Genetic Engineering Appraisal Committee (GEAC)

The Genetic Engineering Appraisal Committee is the apex regulatory body in India responsible for the approval, monitoring, and regulation of activities involving genetically modified organisms (GMOs) and genetically engineered products. It functions under the Ministry of Environment, Forest and Climate Change and operates within the framework of the Environment (Protection) Act, 1986 and the Rules for the Manufacture, Use, Import, Export and Storage of Hazardous Microorganisms/Genetically Engineered Organisms or Cells, 1989[12]. The committee plays a central role in ensuring biosafety, environmental protection, and public health in matters related to biotechnology and genetically modified products.

Originally established as the Genetic Engineering Approval Committee, its name was later changed to Genetic Engineering Appraisal Committee to reflect its broader scientific and regulatory functions[13]. GEAC is primarily responsible for granting approvals for the large-scale use, environmental release, commercial cultivation, import, and manufacture of genetically modified organisms and products. Before granting approval, the committee evaluates scientific data relating to biosafety, environmental impact, and potential risks to human and animal health.

One of the major functions of GEAC is the assessment of genetically modified crops before they are introduced into the environment or commercial market[14]. This involves examining laboratory research, greenhouse studies, confined field trials, and environmental risk assessments. The committee ensures that genetically modified crops do not adversely affect biodiversity, soil quality, non-target organisms, or ecological balance. GEAC also reviews food and feed safety data to determine whether GMO products are safe for consumption.

GEAC became widely recognized in India after approving Bt Cotton for commercial cultivation in 2002, making it the first genetically modified crop approved in the country[15]. Since then, the committee has reviewed several proposals relating to genetically modified crops such as Bt Brinjal and GM Mustard. Some of these approvals have generated public debates concerning environmental safety, consumer rights, and ethical issues, highlighting the sensitive nature of GMO regulation in India.

The committee works in coordination with several other regulatory bodies involved in biotechnology governance. The Review Committee on Genetic Manipulation under the Department of Biotechnology supervises research and small-scale field trials, while Institutional Biosafety Committees (IBSCs) monitor research activities at the institutional level[16]. GEAC generally considers recommendations and scientific reports from these committees before making final decisions regarding approvals and environmental release.

In addition to approvals, GEAC also has powers related to monitoring and compliance. It may impose conditions on approvals, require post-release monitoring, and recommend action in cases of unauthorized use or environmental violations[17]. If genetically modified organisms are released or imported without approval, legal action may be taken under the Environment (Protection) Act, 1986. These powers are important for preventing illegal GMO activities and maintaining biosafety standards.

The role of GEAC is especially significant in preventing food adulteration and GMO mislabelling. By regulating the approval and import of genetically modified products, the committee helps ensure that only authorized and scientifically assessed GM products enter the Indian market. This contributes to consumer safety, transparency, and proper food regulation.

Overall, the Genetic Engineering Appraisal Committee is a key institution in India's biotechnology regulatory framework. Through scientific evaluation, environmental oversight, and regulatory control, GEAC helps balance technological advancement with environmental protection, food safety, and public interest.

FSSAI Labelling Regulations

The labelling framework under the Food Safety and Standards Authority of India is designed to ensure that consumers in India receive clear, accurate, and non-misleading information about food products. These regulations are issued under the Food Safety and Standards Act, 2006 and are mainly governed by the Food Safety and Standards (Packaging and Labelling) Regulations. They aim to prevent food adulteration, misbranding, and deceptive practices such as GMO mislabelling.

The FSSAI labelling rules require that all packaged food products display essential information such as the name of the food, list of ingredients, nutritional information, allergen details, manufacturer information, net quantity, and batch identification. This ensures transparency and helps consumers make informed choices about the food they consume. Any false or incomplete labelling is considered misbranding under the Act and may attract penalties.

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A key principle of the FSSAI labelling regulations is prohibition of misleading claims. Food products cannot use false or exaggerated statements such as "100% pure," "completely natural," or "health enhancing" if such claims cannot be scientifically justified. In the context of genetically modified foods, this is especially important because products cannot be falsely labeled as "Non-GMO" or "organic" if they contain genetically modified ingredients. Such misrepresentation is treated as a violation of food safety standards and consumer protection laws.

Another important aspect of FSSAI labelling regulations is the emphasis on readability and standardization. Information must be clearly visible, legible, and written in English or Hindi, or both, to ensure accessibility for consumers. Nutritional information must be presented in a standardized format so that consumers can compare different products easily.

The regulations also support traceability and accountability in the food supply chain. Batch numbers, manufacturing dates, expiry dates, and manufacturer details allow authorities to track food products in case of contamination, adulteration, or safety issues. This is crucial in addressing food fraud, including GMO-related misrepresentation.

Regulatory Framework in the European Union

The regulatory framework for genetically modified organisms (GMOs) in the European Union is among the most stringent and precaution-oriented systems globally. It is built on a combination of binding legislation, scientific risk assessment, mandatory labeling, and traceability requirements designed to ensure a high level of protection for human health and the environment. The core legal structure includes Directive 2001/18/EC, which governs the deliberate release of GMOs into the environment, Regulation (EC) No 1829/2003, which covers the authorization and supervision of GM food and feed, and Regulation (EC) No 1830/2003, which establishes rules for traceability and labeling throughout the supply chain[18]. These regulations collectively ensure that no GMO product can enter the EU market without prior authorization and detailed safety evaluation.

Scientific risk assessment is central to the approval process and is carried out by the European Food Safety Authority (EFSA), which evaluates potential risks to human health, animal health, and environmental integrity. Only after EFSA provides a positive scientific opinion can a GMO proceed to the political authorization stage involving the European Commission and member states. However, even scientifically approved applications may face delays or rejection due to political disagreement among member states, reflecting the EU's cautious governance approach.[19]

A defining feature of the EU system is its strict labeling and traceability regime. Any food or feed product containing more than 0.9% GMO content must be clearly labeled, allowing consumers to make informed choices. In addition, traceability rules require that GMO materials be tracked throughout all stages of production and distribution, ensuring accountability and facilitating recalls if necessary[20].

Underlying this entire regulatory structure is the Precautionary Principle, a foundational concept in EU environmental and health policy. It permits regulatory action to prevent potential harm even when scientific evidence is not fully conclusive. In the context of GMOs, this means that authorities may restrict or ban products if there are plausible risks to health or the environment, even in the absence of definitive proof of harm[21]. This principle often results in more conservative decision-making, slower approvals, and heightened scrutiny compared to other jurisdictions.

Overall, the EU's GMO governance model reflects a deliberate balance between scientific evaluation and precautionary risk management. While it ensures strong consumer protection and transparency, it also leads to complex regulatory processes and frequent policy debates over the appropriate level of caution in biotechnology regulation.

Regulatory Framework in the United States

The regulatory framework for genetically modified organisms (GMOs) in the United States is generally characterized by a **product-based and biotechnology-friendly approach**, which differs significantly from more precautionary systems such as that of the European Union. Historically, the United States has treated genetically engineered foods as **substantially equivalent to conventional foods**, meaning that if a genetically modified (GM) product is compositionally similar to a non-GM counterpart, it does not require fundamentally different regulatory treatment. This principle of "substantial equivalence" became the foundation for early U.S. biotechnology policy and allowed GM foods to enter the market through existing food safety frameworks rather than through entirely new regulatory pathways[22].

The regulatory oversight of GM foods in the United States is distributed across three major federal agencies under a coordinated framework often referred to as the "Coordinated Framework for Biotechnology." The Food and Drug Administration (FDA) is responsible for ensuring the safety of food and feed derived from genetically engineered crops and evaluates whether such products are safe for human consumption. The United States Department of Agriculture (USDA), particularly through its Animal and Plant Health Inspection Service (APHIS), regulates the environmental release of genetically engineered plants and assesses whether they pose risks to agriculture or plant health. Meanwhile, the Environmental Protection

Agency (EPA) regulates GM crops that produce pesticidal substances, such as Bt crops, under pesticide laws to ensure environmental and ecological safety[23].

This multi-agency system reflects a **risk-based regulatory philosophy**, where GM products are evaluated based on their specific traits and intended use rather than the method of genetic modification itself. As a result, the U.S. framework has generally enabled faster commercialization of GM crops compared to more restrictive systems elsewhere, while still maintaining oversight through existing food safety, environmental, and pesticide regulations[2424] U.S. Office of Science and Technology Policy (1986 Coordinated Framework and subsequent updates on biotechnology regulation).

Comparative Analysis between India, European Union and United States

A comparative analysis of GMO regulatory systems in India, the European Union, and the United States reveals three distinct regulatory philosophies shaped by differing priorities in science, risk perception, and governance. In India, regulation is relatively cautious but still evolving, with oversight primarily handled by bodies such as the Food Safety and Standards Authority of India for food safety and other specialized committees for biotechnology approvals. However, India's system is often characterized by regulatory ambiguity, limited enforcement capacity, and incomplete GMO labeling implementation, which creates gaps in monitoring and compliance. In contrast, the European Union follows a highly precautionary model rooted in the Precautionary Principle, requiring rigorous pre-market approval, strict labeling above defined thresholds, and comprehensive traceability across the supply chain. Scientific risk assessment is conducted by the European Food Safety Authority, but final approvals are often influenced by political considerations among member states, making the process both stringent and complex. The United States, on the other hand, adopts a more biotechnology-friendly and product-based regulatory approach, where genetically modified foods are treated as substantially equivalent to conventional foods unless specific risks are identified. Oversight is divided among the Food and Drug Administration, the United States Department of Agriculture, and the Environmental Protection Agency, enabling faster approvals and commercialization. Overall, while the EU prioritizes precaution and consumer transparency, the U.S. emphasizes innovation and risk-based regulation, and India remains in a transitional stage balancing regulatory development with enforcement challenges.

Conclusion

In conclusion, the regulation of genetically modified organisms (GMOs) reflects fundamentally different governance philosophies across India, the European Union, and the United States. The European Union adopts a highly precautionary

and consumer-protection-oriented approach, grounded in the Precautionary Principle and enforced through strict approval procedures, mandatory labeling, and traceability requirements overseen scientifically by the European Food Safety Authority. The United States, by contrast, follows a more innovation-driven and product-based framework in which genetically engineered foods are generally treated as substantially equivalent to conventional foods, with regulatory responsibilities shared among the Food and Drug Administration, the United States Department of Agriculture, and the Environmental Protection Agency. India occupies an intermediate and evolving position, where regulatory institutions such as the Food Safety and Standards Authority of India are in place but enforcement capacity, labeling clarity, and consistent monitoring remain developmental challenges. Overall, while the EU emphasizes caution and transparency, the U.S. prioritizes technological advancement and regulatory efficiency, and India continues to refine its framework to balance innovation, safety, and effective enforcement in a rapidly changing biotechnology landscape.

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