

# CHAPTER 06



## FOOD AUTHENTICATION FOR FOOD SAFETY AND NUTRITIONAL SECURITY IN SRI LANKA

## Food Authentication for Food Safety and Nutritional Security in Sri Lanka

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**Abstract** Safety and nutritional security of food and agricultural products have become a major concern and challenge in Sri Lanka. The increasing demand, coupled with shortages in food supply, leads to food safety issues and nutritional insecurity. As food quality issues like adulteration and other forms of fraudulent practices are rampant in today's world, sound scientific approaches are required to tackle them. Deliberate or in-deliberate addition of foreign materials and removal of value-added food substitutes frequently takes place in the food supply chain. Hence, international and local regulatory control measures are required to be implemented to safeguard the quality and safety of food commodities. In this backdrop, food authentication can play a crucial role to ensure the quality and safety of food produces in compliance with the standard guidelines. Food authentication throughout the food production and supply lines would aid not only to ensure food safety among the general public but also increase the competitiveness of our local products in the international market. Further, establishing comprehensive data bases on nutritional compositions of locally available agro-food products would help to address nutritional insecurity prevailing in the Sri Lankan Society.

**Keywords:** Authentication, Food adulteration, Food quality, Food safety, Nutritional security

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## Introduction

Product quality, particularly in relation to foods, has gained importance over the past several years worldwide. In many countries, food quality control has become an essential part of the supply chain line from farm to table. Almost all foodstuffs in the market pose quality-related problems in various aspects. The quality issue would become more serious if the food product had a high intrinsic commercial value. In this connection, monitoring of food adulteration or contamination of food with undesirable substances has become a crucial task to ensure the quality of food. Thus, certification of product quality has an added value for product marketing within a competitive system.

Consumers around the world have increasingly become cautious about the quality of the food they consume. Speculative reports of food adulteration in the social media pose a growing challenge to the food manufacturing sector. Owing to this, food manufacturers are at times compelled to confirm the authenticity of their finished products or ascertain the source of origin of the ingredients used in the formulations. Determining the authenticity of food and other agricultural produces has been an ever-increasing challenge. This can help to prevent false descriptions or incorrect labelling, substitution of cheaper ingredients, and other adulteration issues. This increased demand for authenticity comes amid various legislative and regulatory pushes that increase the level of regulation imposed on the food supply worldwide.

## Food Quality Issues in the Agro-food Sector

Because of the growing public awareness of food quality and safety issues, the authentication of food commodities has become a rapidly advancing field of study. Scientific community, law enforcement authorities, food manufacturing companies, and personnel involved in supply chain management are interested in keeping an update on the developments taking place in this arena. A quick review of the literature reveals how many different analytical approaches have been investigated by researchers all over the world to cross-check the authenticity of various food items. As there are numerous practices of a fraudulent nature taking place, it has become essential to take steps to monitor food quality at different stages of production.

### What is Food Adulteration?

Food adulteration is a global concern that adversely impacts the quality and safety of foods. Generally, it refers to the deliberate or inadvertent substitution of inferior foreign materials into food or the removal of value-added food substitutes from the primary food commodity [1]. The practices of adulteration include dilution, unauthorized enhancements, counterfeiting, substitution, concealment, grey marker production, mislabelling, etc. [2]. This process can actually either reduce the nutritional quality or subsequently cause an injurious impact on the consumers or can cause both [3]. An elevated risk of food adulteration can emerge when a country faces a low food supply, leading to an imbalance between the supply and demand. Furthermore, the likelihood of food adulteration would be high in developing countries due to insufficient policies and monitoring mechanisms [4]. This topic is actually contemporary and would be very much relevant to the present economic situation in Sri Lanka in the wake of shortages of commodities in fulfilling the demands of the food sector.

A number of food commodities are known to be victims of either adulteration or mislabelling by the unscrupulous. Milk, butter, honey, olive oil, virgin coconut oil, gee, spices, and tea are some of the common examples of commodities having a high vulnerability to adulteration. Many studies have been carried out in the past to provide insight into potential adulterants in different food commodities. Just a few examples include palm oil in olive oil or rapeseed oil [5], low-grade rice in good quality rice [6], starch, melamine, and water in milk [4-7], invert sugar or jaggery in honey, chicory in coffee powder, brick dust in chili powder, metanil yellow in pulses and turmeric [8], and so on. Over the years, scientific literature has discussed the detection of these adulterants in various food items, emphasizing the need for quality control in the food sector. Some of the most common adulterants that can be found in several food items are shown in Table 1.

**Table 1:** Some common adulterated foods and the respective adulterants

Food	Adulterant	Target parameters and action	References
Milk	Ammonium sulphate	Preservation action to increase the lactometer reading	[9], [10]
	NaCl	To maintain the density of milk, Increase solid-not-fat	[9], [10]
	Sodium bicarbonate, sodium hydroxide	Act as a neutralizer, suppress the microbial growth, enhance shelf life	[10]
	Starch, sugar, sulfate salts	Increase solid-non-fat	[9]
	Urea	To Increase non-protein nitrogen content	[9]
	Melamine, Dicyandiamide	To Increase protein content	[9], [11]
	Formalin, Benzoic acid, Salicylic acid, Hydrogen peroxide	Preservation action, enhance shelf life	[9]
	Vegetable oil	To Compensate the fat content	[9]
	Detergents	Emulsification and dissolve the oil in water	[9]
Honey	Artificial sweeteners: High fructose corn syrup, sugar, maltose syrup, inverted beet syrup	To adjust the sweetness in low quality honey	[12]
	Foreign diastase and amylases	To falsely indicate the freshness of honey	[13], [14]

Olive oil	Olive pomace oil, rapeseed, soybean oil, corn oil and sunflower oil	To increase the bulk	[15], [16]
Turmaric	Starch, chalk dust, wheat or rice flour dyed with colorants like tartrazine, metanil yellow, lead chromate	To increase the bulk	[17]
Coconut oil	Sunflower oil, soybean oil, corn oil, palm oil, fried coconut oil	To increase the bulk	[18], [19]
Virgin coconut oil	Lard, mustard oil, palm kernel oil, palm oil, paraffin oil, mustard oil, re-refined deep-frying palm oil	To increase the bulk	[20], [21]
Tea	Cashew nut husk	To increase the bulk	[22]
	Starch, caffeine, china clay, sand, chicory, leather flakes, french chalk, iron filings, talcum powder	To conceal the quality defect and falsely make the product more attractive	[23], [24]
	Azo dyes: tartrazine, sunset yellow, carmosine, indigo carmine, brilliant blue	To conceal the damage and inferior quality tea	[23]
Green tea	Sibutramine	To enhance weight loss illicitly.	[24]
	Glutinous rice flour	To improve the flavour	[25]

**Milk** is reckoned as one of the foods most frequently subjected to fraud. It downgrades the overall nutritional quality of the milk and can cause numerous human diseases [9-10]. Vegetable protein, whey, milk from other species and water are reckoned as some of the common adulterants found in milk that do not pose serious health issues [9]. Meanwhile, adulterants like sodium bicarbonate, sodium hydroxide, detergents, ammonium sulfate, formalin, urea, melamine, boric acid, salicylic acid, hydrogen peroxide, and benzoic acid are

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reported to have a drastic negative impact on human health [9-11].

**Honey** is a sweetening agent that has good nutritional value and health promotion benefits. After olive oil and milk, honey has the highest likelihood of becoming adulterated in the commercial fraudulent process [12]. Adulteration of honey is reported to have different facets and is categorized as both direct and indirect. The addition of sugar syrups after production and the blending of high-priced honey with inferior quality honey are examples of direct adulteration, whereas overfeeding of bees during the main nectar period is an example of indirect adulteration [13-14, 26-27]. Ferreiro-González et al. [12] stated that the addition of inexpensive sweeteners to pure honey is the most commonly practiced adulteration method. Among the different types of sweeteners, high fructose corn syrup is used often due to its low cost as well as its compositional similarities to honey [12]. Honey proteins are reported as an important compound associated with honey properties [13]. The diastase/amylase activity serves as one of the quality parameters of honey that is indicative of the freshness and overheating of honey [14]. Therefore, their loss in activity is indicative of the inferior quality of the honey. In this matter, foreign amylases are being added to honey to mask the quality loss of honey [13].

**Spices** hold great economic value in both local and export markets. As their trading process goes through a complex supply network, they pose a high risk of vulnerability to adulteration. The increasing demand and high prices of spices appeared to have fueled the temptation to engage in fraudulent practices [17, 28-29]. Turmeric (*Curcuma longa*) is a famous spice that has been extensively used in traditional cuisine and medicinal applications. In an attempt to increase the bulk of turmeric, dyed materials such as rice flour, starch, wheat flour, and chalk dust, pre-extract rhizomes, low-quality spices, and cheap natural ingredients are commonly added to turmeric powder [17]. In this regard, metanil yellow, tartrazine, and lead chromate are reckoned as some of the most frequently used colorants [17]. Black pepper is reckoned as the "King of spices," which claims its demand for a great economic value among different spices. Cheaper bulking materials such as papaya seeds, non-functional pepper substances like defatted pepper materials, pepper husks, and pinheads are some of the common adulterants in pepper [29-30].

**Tea** is a globally famous beverage, being consumed abundantly around the world and coming in different types and grades. Some of the high-grown teas are expensive and commanding a high price in the market. Various adulterants, like plant-based materials and inorganic substances, are being added to tea in fraudulent practices. Among those, cashew nut husk is reported to be used more often as a plant-based tea adulterant [22]. Furthermore, starch, caffeine, china clay, sand, chicory, leather flakes, french chalk, iron filings, talcum powder, Environment Sustenance and Food Safety: need of more vibrant policy initiatives for Sri Lanka



are some other potential adulterants of tea [23–31]. Low-grade black tea is often dyed with artificial colorants like azo dyes to cloak its inferior quality or damage [23-32]. Green tea is scarce in production and reputed for its claimed health benefits. Illegal adulterations of tea with sugars and glutinous rice flour [25] and synthetic slimming substances like sibutramine may pose adverse impacts on human health, leading to strokes and heart attacks [24].

**Olive oil** is well known for its extensive sensory, nutritional, and health characteristics. It is a fundamental ingredient of the reputed Mediterranean dietary pattern [16]. Generally, olive oil comes in different grades as they fall under different quality categories based on their fatty acid composition, degree of acidity, peroxides, spectrophotometric index, and sensory attributes. Amongst, the alkyl esters of fatty acid composition of olive oil are reckoned as an important quality parameter where the quality of the oil would decline when their value is higher than the legislative recommendations [33]. Among the different grades of olive oil, extra virgin olive oil is reckoned as a premium product with a high tendency to be adulterated due to its high commercial value and supply shortage [34]. Adulteration of olive oil could take place in a number of ways where the most primary way of adulteration refers to the partial replacement of the oil with other low-priced commercial oils like low-grade olive oil, pomace oil, rapeseed, soybean, corn, and sunflower oils [15-16].

**Coconut oil** is frequently used in oil-based culinary practices both in the industry and households. Moreover, it might act as a functional food pertaining to its unique saturated nature that comes with small-to medium-chain fatty acids [18]. Owing to the body of knowledge-based evidence, the commercial value of virgin coconut oil is undergoing rapid growth and is becoming a valuable source of nutrition, similar to olive oil [20-35]. As there is a high demand in the market place for coconut oil, this triggers the profit-motive adulterations by the traders in the oil business. Some common adulterants of coconut oil are palm oil, other low-priced vegetable and seed oils, or fried recycled coconut oil [18-19]. In several Asian countries, coconut oil is reported to be adulterated with palm olein and sold as a “genuine” product [34]. Palm kernel oil, palm oil, paraffin oil, mustard oil, re-refined deep-frying palm oil, and low-cost animal fats can be reckoned as other common adulterants of virgin coconut oil [20-21]. These kinds of fraud and falsification could not only ruin the organoleptic properties of virgin coconut oil but also its health outcomes.

#### Food safety Policy Gaps in Agro-food Sector

Food authentication exercises would help in many ways to ensure food safety among the general public of a country. Food safety issues are multifarious based on the nature of different food systems. Outbreak of food-borne diseases is a

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particular concern as the economic costs associated with foodborne diseases can be severe on people, food companies, and a country’s reputation. They can cause short-term symptoms, such as nausea, vomiting, and diarrhea (commonly referred to as food poisoning), but can also cause longer-term illnesses, such as cancer, kidney or liver failure, brain and neural disorders. These diseases may be more serious in children, pregnant women, elderly people, and those who have a weakened immune system. The causes are unhygienic practices in food production, harvesting, and preparation. A lack of accurate data on the full extent and cost of foodborne diseases has been a major obstacle to address food safety issues. In order to fill this data gap, research institutions and regulatory authorities could make necessary contributions through specific programs of action.

With the advancement of technology, various food additives are increasingly being used in processed food items with demand long shelf life. Often times, additives are used as preservatives, colorants, flavour enhancers, stabilizers and taste and texture improvers, etc. Some of these additives might have negative consequences for the health of the consumers, being associated with possible carcinogenic effects [36]. Nevertheless, additives, which are toxic in nature, would not pose any hazard to human health if they are present below certain limits according to regulatory guidelines. Hence, updated national level policies and guidelines are required to implement the regulatory control over the use of these additives in commercial food production. Frequent amendments and revisions are required to be carried out for regulatory control guidelines with the advancement of scientific knowledge.

The perception of consumers regarding the intake of foods containing high levels of chemical additives has changed considerably over the last few decades. Owing to the adverse side effects of some of the chemical preservatives on consumers’ health, food suppliers have demanded foods to be microbiologically safe with no chemical preservatives in them [36]. As a result, research on alternative antimicrobial strategies and systems should begin using knowledge of the physiological responses expressed by various microorganisms [37-38].

Process-induced toxicants are becoming big food safety issues in the food manufacturing sector. Acrylamide is one such example of a process-induced contaminant occurring in fried products like French fries. The toxic nature of acrylamide has been well established by now [39]. Frequent monitoring of food supply outlets in Sweden, the UK, and Denmark has led to the detection of acrylamide contaminated foods. As this kind of surveillance is hardly operational in Sri Lanka, the exposure of these contaminants is not known in detail. Food control authorities should therefore make this a national priority by allocating funds for the development of analytical methods for routine cross-check in

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major cities.

Food irradiation is the treatment of foods by ionizing radiation in the form of beta, gamma or X-rays [40]. It has been increasingly becoming a means of reducing the microbial load in herbs, spices, potatoes, flour, packed pork and beef, etc. Although this technology provides many benefits to the food industry in terms of shelf-life extension, certain segments of society do not like to eat irradiated foods on the grounds of perceived health risks. Some improvements are therefore necessary to revise the food labelling practices in Sri Lanka for consumers to identify irradiated foods easily. Regulatory agencies in Sri Lanka should also develop necessary legal policies to determine ways to identify and label irradiated foods using appropriate terminology.

### Need for Comprehensive Food Data-bases

Establishing comprehensive food compositional databases is essential for various food commodities to facilitate their food authentication. This should be done by national level bodies responsible for upholding standards. This kind of initiative would not only help to curb fraud by unscrupulous practices happening in the local trade, but also facilitate the enhancement of the superior quality of local produces in the competitive marketing system. The Department of Agriculture, Sri Lanka recently compiled the proximate composition and mineral composition of various bean varieties locally grown in the country [41]. Likewise, the systematic data compilations for several other food commodities should be encouraged in the future by allocating funds for research, infrastructure facilities, and other resources. This can be further strengthened by efficient information sharing through networking among different government agencies.

Food compositional data bases play a significant role in food authentication and quality assurance. Hence, accuracy and reliability in food compositional databases are of prime importance. Accomplishment of this task should be done through accredited laboratories having validated methods of analysis. These databases should contain information about macronutrients and micronutrients. Macronutrients are required in larger quantities and include carbohydrates, lipids, and proteins. Micronutrients are those that required in smaller quantities and include vitamins and minerals.

In classical authentication, the proximate compositional data of food samples can be used as references for cross- checking the suspected sample to see if its values deviate significantly from the range found in the reference [42]. This approach has been successful in many cases as it is remarkably sensitive to adulterations. When using this method, detecting adulteration becomes more

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difficult if the composition of the adulterant and the authentic material become too similar. In such cases, alternative strategies proposed by various research groups need to be adopted by regulatory bodies [43]. In this regard, some examples from the oil and fat sectors could shed some light on the issues to get better clarification. Coconut and palm kernel oils are two examples of lauric oils with similar fatty acid profiles. Despite some differences due to the country of origin, the fatty acid compositions of olive oil and canola oil were similar [44]. Likewise, fatty acid profile similarities were noticed in cocoa butter and cocoa butter substitutes [44-45].

Thermal analysis by differential scanning calorimetry (DSC) has been a potentially useful technique in food authentication. In a pioneering effort, Dyzel and Baish [46] demonstrated the use of DSC in the identification of various edible vegetable oils. This study triggered the curiosity among the research community to investigate the use of DSC to establish the standard reference curves of several plant oils [44-45], and animal fats [47-48]. The DSC output, coming in the form of melting and cooling curves, could serve as fingerprint to identify different oils and fats. If any significant deviation is detected in the DSC curve of a particular oil or fat with respect to the standard reference curve, it can be taken as preliminary evidence of adulteration. Food control authorities in a country should encourage the use of this modern authentication technique for quality assurance of locally produced oils, dairy products, spices, and essences.

### Nutritional Insecurity

Nutrition insecurity can be defined as the inability to access adequate quantities of nutritious foods required for optimal growth and development. It has been recognized that well-nourished people are healthier, better learners, and more productive in life. Although Sri Lanka performs well in most health indicators, child nutrition among those below 5-years is still a major challenge. Severe vitamin A deficiency is one of the major public health problems in rural Sri Lanka, causing increased susceptibility to infections and permanent damage to both eyesight and development. According to multiple reports, the most vulnerable groups are children younger than five years and women of reproductive age [49].

There has been a close link between nutritional insecurity and food adulteration. There are a host of fruits that are low in supply due to their existence in particular regions of the world. In such cases, adulteration of fruit products by some manufacturers and suppliers is inevitable, as they usually add cheaper substitutes to highly valued fruit products. This practice can affect the nutritional value, sensory attributes, and chemical composition of the authentic products, violating consumer's rights and expectations. Therefore, monitoring of the

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authenticity of food products, including fruit juices, represents a demanding and necessary task to be performed by regulatory agencies.

In general, there has also been a close link between nutritional insecurity and climate risk all around the world. Experts believe that climate change accompanied by extreme weather patterns is a concern for the productivity of all arable crops in Sri Lanka. The nutritional qualities of various foods may be at risk due to factors that affect plant nutrient uptake. This kind of climate risk would lead to nutritional insecurity across many developing countries in Asia and Africa.

Food authentication could lend a helping hand to assess nutritional losses caused by various food processing operations. Generally, the nutritional composition, bioactivities, and functional properties of raw food items are affected by the application of different food processing methods such as freezing, thawing, baking, drying, frying, etc. [50]. Remedial measures to retain essential nutritional attributes of foods may be taken if food authentication is carried out to cross-check the short fall in nutritional quality due to processing.

## Conclusions

The rising prevalence of fraudulent practices in the food sector has become a critical concern in terms of food quality and safety. Exercises of profit-motivated and nutritional insecurity related food adulteration with cheap substances and hazardous materials would not only impact on the quality of food but also on consumer health. Thus, regulator bodies have made establishments to control food falsification by making guidelines for different food parameters. Therefore, food authentication is crucial and must be implemented throughout the production process of food and agricultural produces. However, the authentication process could vary based on the type of the adulterant and the commodity type, and interestingly, a number of analytical methods have been developed to accomplish this aspect. Meanwhile, the development of accurate and descriptive nutritional data bases on macro and micronutrients of different food commodities would greatly assist the food authentication process. Therefore, food authentication practices accompanied by generating nutritional databases are essential in order to ensure the overall food quality. However, further and fine-tuned authentication practices are warranted

## Acknowledgement

Authors gratefully acknowledge NIFS, Kandy for funding.

## Conflicts of Interests

The authors declare that there is no conflict of interest.

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