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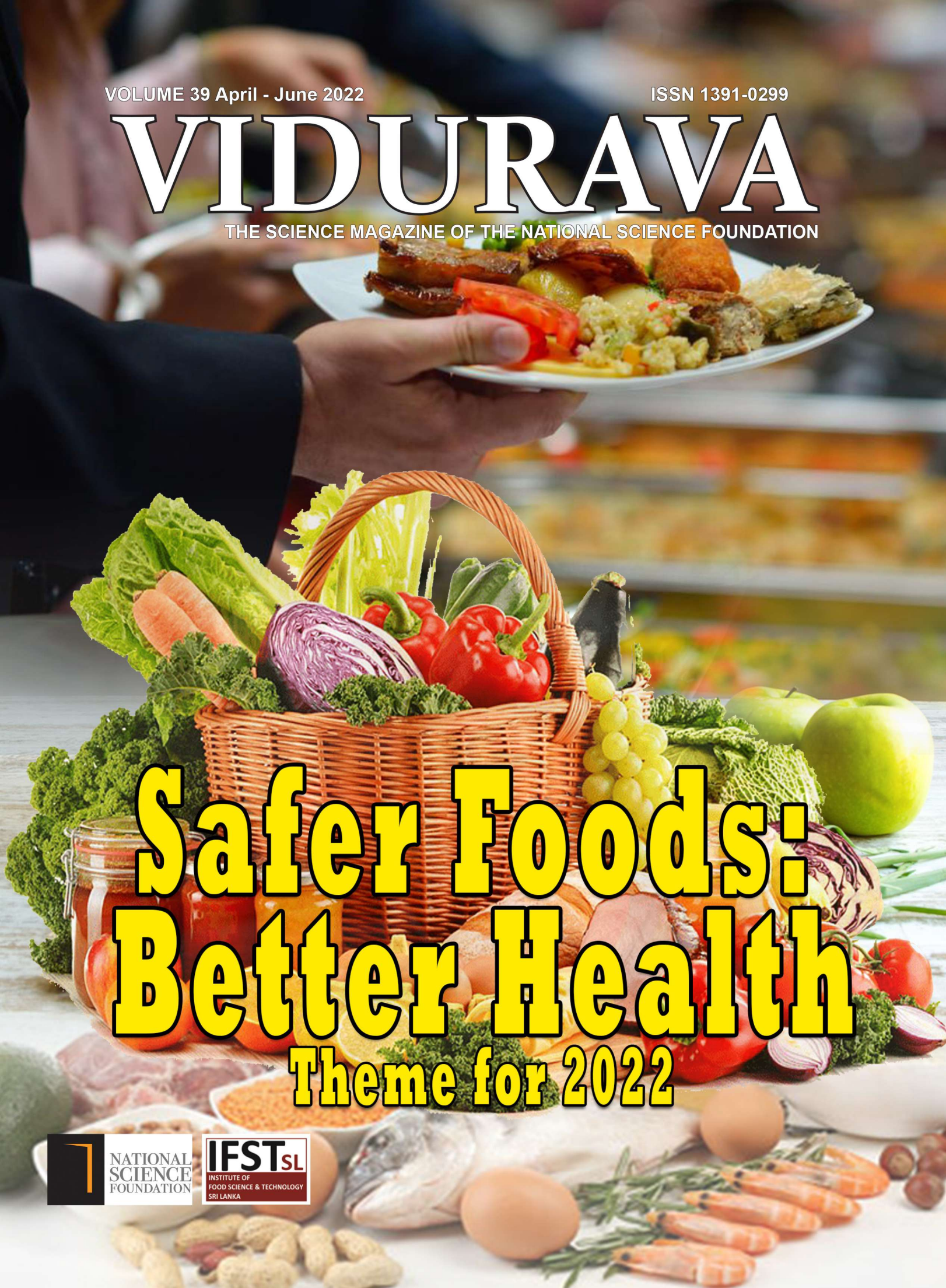

Safer Foods: Better Health

Theme for 2022

NATIONAL SCIENCE FOUNDATION

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VIDURAVA

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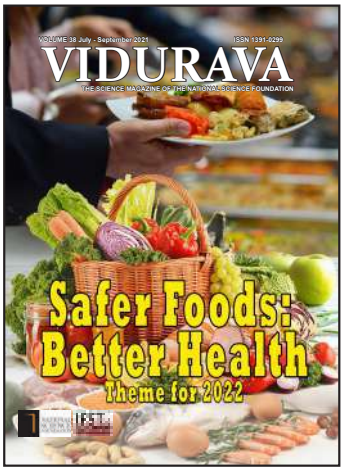

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Editorial

Production of Safe and Healthy Food

This number of the *Vidurava* deliberates on public health in the context of production, packaging, and delivery of healthy and wholesome food to the people of this country. The themes include, 1) Safer Food – Better Health, 2) Pesticide Residues and Food Safety, 3) Regulating Food Safety for Improved Public Health, 4) Packaging Food for Safety, 5) Safe Use of Additives in the Food Industry, 6) Food Safety in the Sri Lankan Hospitality Industry and 7) Polycyclic Hydrocarbons in Food Safety.

The discernible scientific concerns in these articles are unavoidably complex, and may sometimes be beyond the comprehension of the traditional readership of the journal. Nevertheless, setting in place the correct procedures to be followed in this arena of activity is important, and needs to be popularized.

It is not however, possible to ignore the historical fact that it was the introduction of the commercial oriented plantation industries at the turn of the 19th Century that spurred the irregulated use of toxic chemicals for pest and weed control in Sri Lanka leading to unsafe food production.

Prior to the introduction of plantation crops, farmers in ancient times were intelligent enough to find non-toxic plant-based ingredients to control and manage pests, diseases, and weeds, thereby ensuring safe and healthy agri-products for the people. The ancient customs and rituals, and traditional practices of our forefathers with a holistic approach, resulted in a system of crop production that was not designed to compete with nature for resources, but tended to work in harmony with the living natural environment. There was thus no necessity to impose any regulatory measures for food production in ancient times.

In fact studies done by the present writer has shown how classical writers and commentators like A.K. Coomaraswamy (1895), Robert Knox (1681), J.W. Bennett (1843), J.P. Lewis (1902), E. Goldsmith (1982), J. Parsons (1908), and H.C.P. Bell (1883), had occasions to observe with enthusiasm, and comment on Sri Lanka's traditional systems of food production. Although the use of additives for food was not a tradition, the availability of a wide range of spices, provided culinary opportunities to alter the taste, colour and smell to satisfy the needs of the consumers. It had also been known that there had been several procedures for preservation of food for periods ranging from 6 to 12 months. Among these methods of preservation of food, several types of flour were made and used by rural folk. Varieties of yam had been sliced, sun-dried, and powered, which were then wrapped in pieces of cloth and kept above the hearth for fumigation to enhance the keeping qualities, as well as to reduce pest damage. With regard to colouring, the tuber *Rajala* had been used to provide colour variants, if necessary, for food. In conclusion, it could be said that the current day food safety concerns such as pesticide residues, use of special techniques of food preservation, as well as use of food additives were not public health concerns in ancient Sri Lanka.

M. Asoka T. De Silva

Safer foods - Better health

Emeritus Professor Upali Samarajeewa

"Safer Foods - Better Health" is the food safety theme of the United Nations for the year 2022. It underscores the relevance of consuming safe food for a healthy life. Every year, the United Nations food safety day falls on the 7th of June. The day was established in December 2018 recognizing the need to ensure a safe food supply to everybody. The world food safety day aims to draw attention and inspire action to prevent, detect, and manage foodborne risks affecting human health, economic prosperity, agriculture, market access, tourism and sustainable development in each and every country. Sri Lanka is no exception.

Food cultures and food habits started moving across the country boundaries with globalization, and populations moving to settle in other countries. Food became a world trade commodity with the practices of cultivation, food processing, food preparation, food handling and consumption moving across cultures. This change brought in the need to examine food cultures with deeper scientific understanding. The developments in science and technology explored new avenues to modify the traditional food, preserve them, and make them attractive to the consumers. Ever expanding global populations, and diminishing land availability for farming, both agricultural crops and animal production, compelled the farmers to introduce new methods to increase yields to maintain food security. Food safety also became a vital component in food security.

The modernization of technologies for food cultivation and food processing, necessitated use of mechanisms to increase yields and preserve foods, aiming transport across country boundaries. Essentially, modernization had with it demands for new practices, innovative technologies, new food varieties and new processes, away from the traditionally accepted food production – consumption systems. New foods face new challenges. Today, there is the need to prevent the entry of harmful constituents into foods, and to utilize hitherto unutilized crops as food. Food safety hazards arise from a variety of unchecked activities along the food chain, from farm to the plate. The series of activities occurring along the food chain and the checks in the form of thresholds and regulations needed to ensure food safety are presented in figure 1.

Thresholds indicate the limits of inputs or constituents naturally present in soils above which contributions to a food crop may make it unsafe. Regulations guide the limitations expected in practices. The activities in the food chain are in the hands of manufacturers of agricultural inputs (fertilizers, pesticides, veterinary drugs), the farmers, the food manufacturers, food handlers during transport, during food preparations and at serving to the consumers. The entities causing food safety hazards may take the form of chemicals occurring as contaminants in soils such as toxic heavy metals, overuse of chemicals to increase crop yields, exposure of foods to harmful particles physically, the entry of pathogenic bacteria and the molds producing toxins. The food raw materials themselves may contain undesirable constituents such as allergens and antinutrients. Controls and checks to prevent the entry of hazardous substances to foods need to be

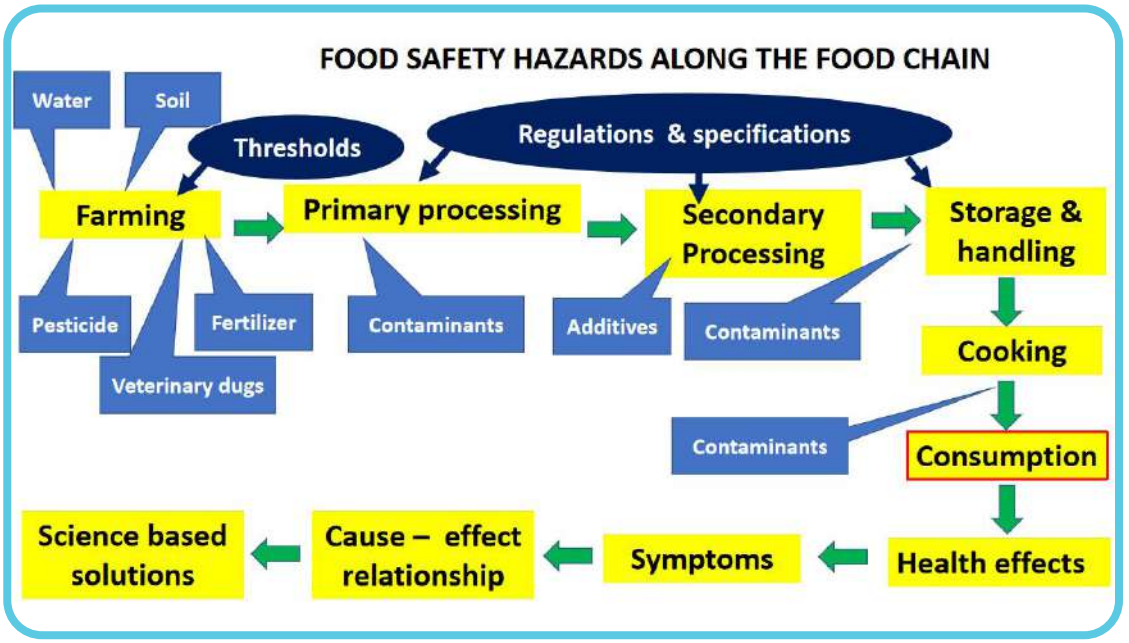

Figure 1: Steps in the food chain and the points of entry of harmful ingredients to foods leading to food safety hazards.

implemented systematically and scientifically, with a proper plan to ensure food safety. Checking a food item at the market by expensive test methods cannot ensure public health, as the foods may have already moved into hands of the consumers.

In the world population, about 600 million persons suffer annually due to health problems arising from unsafe foods. The World Health Organization has shown that 420,000 persons lose their lives annually due to consumption of unsafe food. Many more lose their productive capacity. Among them, the children, the sick, the elderly persons are more susceptible to food borne illnesses. In Sri Lanka we hear through the new media of groups of persons, namely the school children, persons attending common social activities, persons employed in specific work situations such as factories, and persons engaged in group travel, fall sick leading to hospitalization.

The root cause is either a problem in the raw materials used or more commonly a contamination occurring along the practices identified in figure 1, without giving attention to the regulatory aspects and good hygienic practices by the food handlers. Taking precautions to prevent the entry of harmful constituents into food is a responsibility of everybody, aiming to the betterment of public health.

Recognizing the origins of the food safety problems and understanding the need for a different preventive approach, developed and developing countries in the world changed their food control systems creating new regulatory mechanisms and regulatory bodies, during the last decade. The changes that were introduced by different countries are listed in table 1.

The table shows a change from the previous concepts of food control to new approaches with food safety management along the food chain. The control approach in Sri Lanka looks only at the end products of the food chain by testing. The systems of testing end products have failed to ensure food safety in every country. Sri Lankan government is yet to introduce a food safety management system in line with the other countries. The non-governmental organizations are introducing food safety management systems in Sri Lanka with no recognition by the State food control system.

Food safety is clearly a responsibility of all stakeholders as explained earlier. The checks used in the other countries along the food chain, starts with a series of good practices. These good practices consists of Good Agricultural Practices (GAP) and Good Veterinary Practices (GVP) applied at the farm level and during primary processing of foods. Primary processing is the cleaning stage of crop harvest removing soil particles and separating non-edible components in the agricultural raw materials. In the case of the meat industry, the primary processing amounts to removing components not acceptable for consumption from the animal carcasses, and presenting the components meant to be consumed. The

Table 1: New food safety control systems introduced in different countries for better health

Moving towards food safety by countries

Country	Year	New regulations / regulatory bodies
Europe	2002	European Food Safety Authority
Japan	2006	Food Sanitation Law
India	2011	Food Safety and Standards Act of India
Pakistan - Punjab	2011	Punjab Food Authority Act and Pure Food rules
USA	2012	Food Safety Modernization Act
Canada	2012	Safe Foods for Canadians Act
Bangladesh	2013	Food Safety Act
P R China	2015	Food Safety Law
Australia	2017	Imported Food Control Amendments Bill
Sri Lanka	1980	Food Control Act No. 26; Amend 1991 & 2011

Department of Agriculture operates a certification scheme for Good Agricultural Practices. A similar scheme for Animal based food production is yet to be introduced.

At the level of food processing, Good Manufacturing Practices (GMP) and Good Hygienic Practices (GHP) are essential to ensure food safety. The GMP address the basic layout and practices necessary in a food processing facility to prevent the entry of harmful agents to food through machinery, the practices of the employees, and the entry of rodents insects etc. bringing in disease causing bacteria into the food processing facilities. The GHP address the acceptable sanitary behavior by the food handlers to ensure food safety.

When the United States of America launched human beings in a spaceship to the moon travelling for weeks in a capsule, they foresaw the need to ensure good health of the astronauts through safe food in their long journey. The USA scientists designed a system to ensure safety of the food to be consumed by the astronauts. The system is described as the Hazard Analysis and Critical Control Point system (HACCP). The HACCP system consists of two components. The first component is Hazard Analysis. It means recognizing and assessing the potential hazards in the foods. The hazards may be arising from constituents originally in the raw material, chemicals used in processing or the disease-causing microorganisms entering the food. Hazard analysis is done by a team of scientists consisting of chemists, microbiologists, food scientists and engineers. The second component is Critical Control Points. In this component, the events occurring in the food production or processing chain are examined scientifically, and the points or locations where the hazardous substances may enter the food are identified. At the identified critical points, controls such as maintaining correct temperature, acidity etc. are introduced to rectify the faults. In the food production or manufacturing chain, checks or tests are introduced to find whether the control measures at critical points are successful. It ensures addressing food safety along the food chain preventing continuation of food safety hazards to the market products.

For success in a HACCP system, the food industries need to set the basic layout of the good manufacturing practices (GMP) and good hygienic practices (GHP) of the employees. The food safety management systems are developed through a series of activities linked to each other starting from GMP

and GHP. The linkages among the series of activities are presented in figure 2.

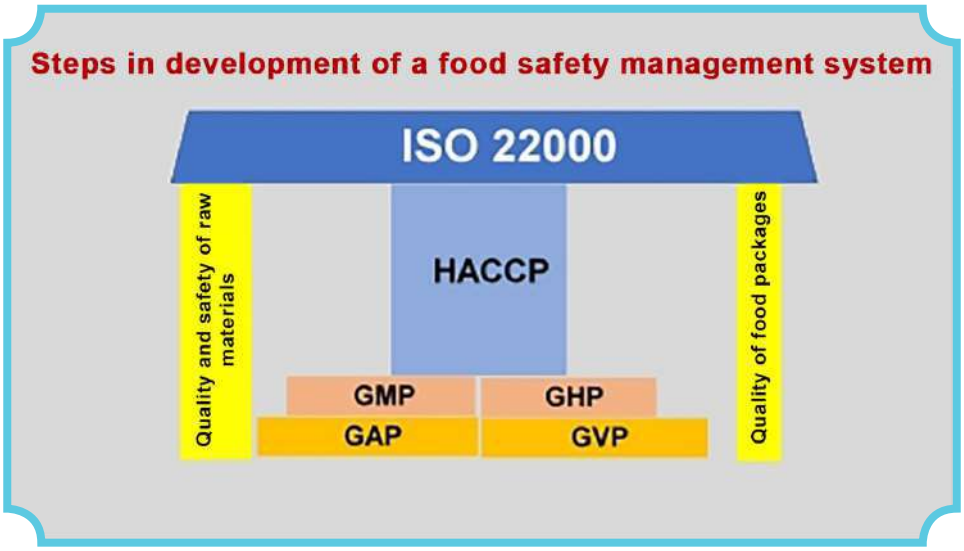

Figure 2: Series of activities to ensuring food safety during processing

All food safety management systems in the World are built on the concept of HACCP. HACCP becomes meaningless without the good practices on which it operates. The diagram identifies the positioning of the most widely used food safety management system based on concepts of International Organization for Standardization. It is identified as ISO 22000, which is based on HACCP. HACCP works with successful GAP, GVP, GMP and GHP.

Arising from the linkages shown in figure 2, it is clear that food safety should begin at the farm and monitored to meet the international standards. There are guidelines for selection of locations for farms, the quality of water to be used, the amounts of fertilizers to be applied, the types and amounts of pesticides to be applied and a period that should be adhered to between applying pesticides and harvest. Similarly, there are guidelines on the use of drugs on animals and the time periods required before milking, collecting eggs, or slaughtering animals for food purposes. Then there are guidelines for processing, storage and handling of the foods. All these guidelines issued by the respective authorities need to be followed in ensuring food safety. Thus, the food safety becomes a responsibility of everybody and not only the food control system of a country.

At the global level, there are agreements of the World Trade Organization which needs to be followed in ensuring food safety. The agreements address the need to prevent movement of plant and animal diseases across country boundaries and the necessity to implement equivalent testing standards in all countries. Sri Lanka, as a signatory follow the regulations in protection our territories from possible invasion of disease-causing organisms. The recent rejection of organic fertilizer from another country on the ground of organisms that may bring in new problems in Sri Lanka is a good example of implementation of the agreements. Rejection of foods are done at the entry points to the country if they appear to carry food safety hazards.

Ensuring food safety within the country is important for Sri Lanka due to several reasons. Sri Lanka is a well-recognized tourist destination due to its natural beauty. Tourism creates potential to earn foreign currency. Tourists prefer countries where they do not get exposed to unsafe foods. Properly implemented food safety management systems and the adherence to international food regulatory principles form an important part in ensuring "safer foods for better health". This applies both for tourists as well as for the Sri Lankan population equally. Sri Lanka also has a very high potential to export foods to earn foreign exchange. The export markets expect several features in foods including the quality and safety. The basic needs are highlighted in figure 3.

Tea cultivation and processing were introduced to Sri Lanka by the British. One could see even after hundreds of years that the leaves and bud plucked from the tree are immediately put into a basket. Leaves are never allowed to contact the soil at any stage of processing. Sorting of the plucked tea leaves is done on a polythene sheet spread on a cement floor. It is a part of good agricultural practices. Unfortunately, the green leafy vegetables we export contact soil at harvest and get contaminated with disease causing

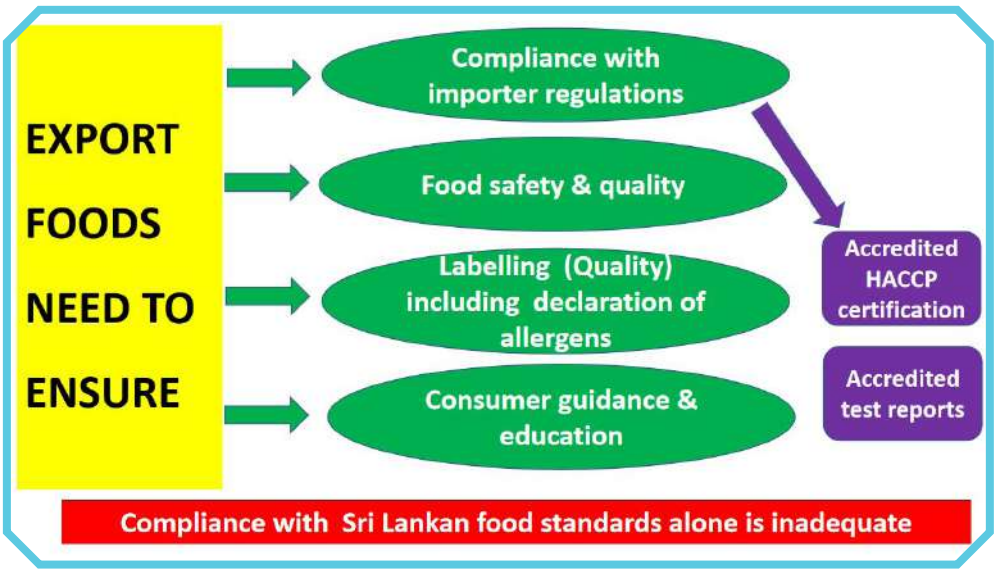

Figure 3: Basic features to be met in export of foods

microorganisms like Salmonella. The exports get rejected at the border points to European countries. The responsibility of food safety is obviously not linked to testing of the end products, but the practices along the food chain. In early 1950s our desiccated coconut lost the markets due to presence of Salmonella. Authorities had to modernize all the desiccated coconut factories applying the modern principles of food safety management discussed above, to regain the lost markets.

The food safety management systems maintained in developed countries are monitored by more than one authority. The organization employ a quality manager. The food safety management certification body conducts regular technical audits on the processing line. The inspectors of the government regulatory body check the practices against the documented HACCP system or other food safety management systems. The three-layer approach ensures that the market products are safe. Though there is much done by the Sri Lanka Standards Institution to popularize the food safety management systems, and carry out auditing, fulfilling one layer of activities, there is much room for improvement.

Coming back to the issue of three-layer protection, Sri Lankan food control system is yet to engage a group of persons with food safety knowledge to address the safety of food in the markets. Occasional testing of the market food samples and fining the seller after many months of legal procedures cannot ensure food safety of the nation. Most of the regulations in the Sri Lankan food control system address the food quality rather than food safety. There is also a misconception among even the health practitioners that the foods should be 100% free of harmful ingredients. It is a good theoretical concept, but not a practical approach. In addressing food safety, much research is done to recognize the concentrations at which harmful constituents in foods could be tolerated by human beings without getting into health problems. This information is used to recognize the levels of risks and the safe levels of exposure. Tolerance limits for constituents in foods based on risk assessments, are established and converted into regulations in the developed countries. It needs a collective effort of the stakeholder authorities in the food chain.

If a product in the market shelf is found faulty at testing in most developed countries, the producer is compelled to withdraw the whole lot, and let the consumers know the reason why the product was withdrawn. Two years back, 'Aluwa" in the markets in five provinces of Canada had to be withdrawn because the label did not indicate that the food carried small amount of wheat flour. After preparing 'Aluwa' a small amount of wheat flour is sprinkled on it. Wheat flour is an allergen, which should be declared in foods in all countries. Sri Lanka does not possess regulations to this effect.

The responsibilities on the quality and the safety of foods along the food chain are in the hands of several authorities outside the food control system in Sri Lanka. Food safety could be achieved meaningfully only by a collective effort of the stakeholder groups. Unfortunately, the current food control system in Sri Lanka is not geared to work with other groups or use food safety management systems as the major approach to ensure food safety.

Food scientists in Sri Lanka have examined this situation and proposed the creation of a food safety authority in line with the

bodies in other countries listed in Table 1. Essentially Ministries of Agriculture and Health must work together in this approach. There are other bodies such as Consumer Affairs Authority who are currently addressing the food safety issues at the local level. The fisheries sector in Sri Lanka has gained much experience in handling food safety for export fish through their efforts to meet fish import regulations of the European Commission countries. There is much to learn from other countries and to be practiced. Taking all these aspects into consideration a structure for a Food Safety Authority is proposed. It is outlined in Figure 4.

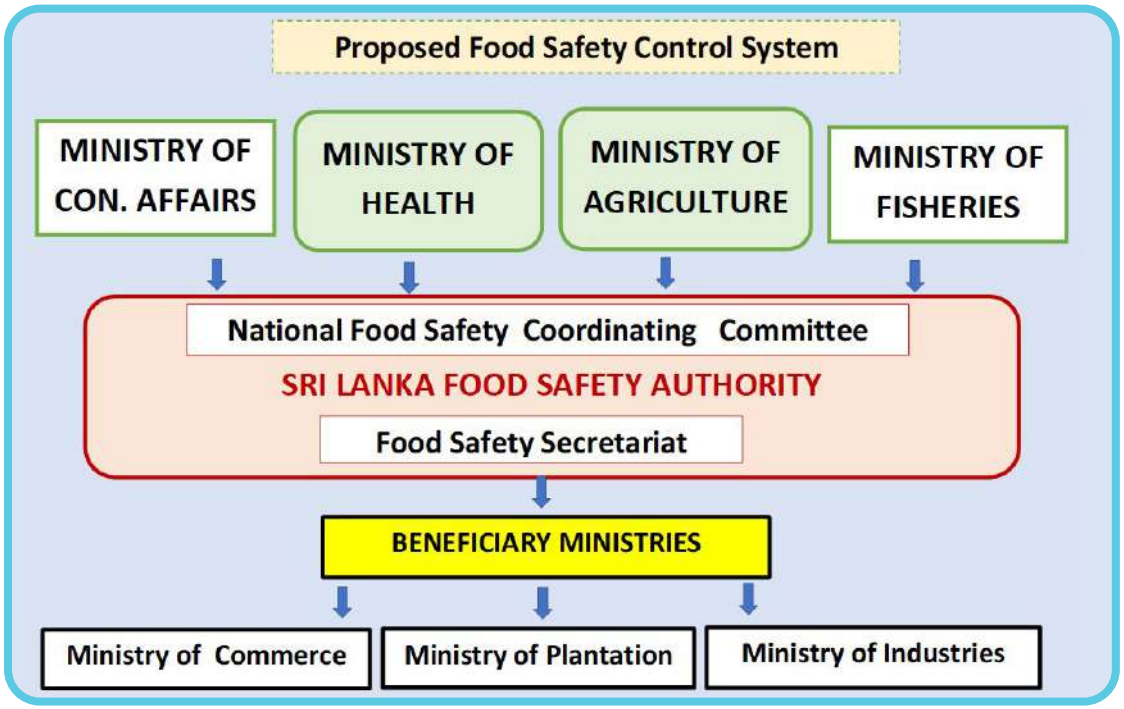

Figure 4: Proposed structure to establish food safety authority to manage food safety in Sri Lanka

A food safety management system require horizontal food standards. In horizontal food standards, the regulations cover all the food items that may carry a particular food safety hazard. However, limits of tolerance would be different for each food considering the amounts of the food consumed, the concentrations of harmful agents present in the food and the risk associated to different populations from exposure to the hazard. It is not possible to copy a set of standards from another country and plant it in the local system as our exposures and our problems would be different. It is also not possible to establish a food safety regulation that would affect the food security severely in a country. A study in the USA on arsenic (As) content of rice has shown that reducing the tolerance limit to half the current level, would make rice unavailable in the market by 4 - 93 % depending on many other factors. Addressing food safety need deep understanding of the problems by scientists representing different disciplines working together. Therefore, a much broader approach is necessary through a national food safety authority like other countries as shown in table 1.

This issue of Vidurava bring together the scientific information necessary to address issues related to several food safety hazards in the country and to look at the regulatory aspects, the tourism related issues and means to protect foods from entry of harmful ingredients.

(The author acknowledge the use of many scientific publications in producing this document for educational purposes)

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Safe use of additives in the food industry

Prof. Niranjalie Perera

Introduction

Food additives play an important role in meeting consumer satisfaction and providing a safe food supply. The use of food ingredients to enhance the quality of processed foods dates back to many centuries. Use of common salt or sodium chloride to preserve dried fish; bee honey containing sugars to preserve meats; and spices nutmeg and cinnamon etc. to flavor foods are common examples. Food additives became an essential need in the rapidly expanding food industry to achieve technological developments. Food processors generate foods according to the demands of the population, especially the consumers seeking quality foods in terms of safety, nutrition, and convenience with extended shelf-life.

What are food additives?

Food additives may be defined as chemical substances deliberately added to food in known and regulated quantities, for the purpose of assisting in the processing, preservation or improving the flavor or appearance of foods. The Joint Expert Committee of the Food and Agriculture Organization and the World Health Organization (JECFA), defined food additives as non-nutritive substances which are added either intentionally to food, in small quantities to improve their appearance, flavor, texture or other secondary properties, or find their way otherwise, into food during handling, processing or distribution. The Codex Alimentarius Commission (1979) defines food additives as any safe substance, not normally consumed as a food, irrespective of their nutritive values, intentionally introduced to food, for technological purpose in the food manufacture, processing, packaging, transportation, or storage of food. To consider as an additive, it should provide some acceptable functions for the particular food. Those functions can be preserving the nutritional quality of the food, improving the keeping quality, improving the organoleptic properties, or enhancing the stability of the food.

Figure 1: Food labels indicating natural and synthetic additives

Types of additives used in the food industry

Basically, food additives could either be natural (available to be obtained from foods), or synthetic. Natural additives are extracted from plants, animals, or minerals while synthetic additives are of chemical or enzymatic origin. Natural additives include natural antioxidants, antimicrobials, colorings, and sweeteners. Polyphenols form one exciting group of natural compounds showing functional properties in foods. They act as natural antioxidants. Tea is a rich source of polyphenol antioxidants. All classes of polyphenols, including phenolic acids, flavonoids, anthocyanins, tannins, lignans, stilbenes, and coumarins, show antioxidant activities. Ascorbic acid (Vitamin C) and carotenoids in plants and fruits also act as natural antioxidants. Natural colorings include carotenoids, caramels, curcumin, etc. The synthetic antioxidants include butylated hydroxy anisole (BHA) and butylated hydroxytoluene (BHT). The use of BHA and BHT is limited in baby foods due to food safety concerns.

Apart from the primary classification, there are several other classifications. Food additives are grouped as flavoring agents, enzyme preparations, and other additives by FAO/WHO based on their functions. The flavoring agents are used in the food industry to improve the sensory properties of foods, such as taste and aroma.

Coding systems for food additives

There are two coding systems to identify additives. The system of the European Union (formally the European Economic Commission) use prefix 'E' before the number. The International numbering system developed by Codex uses the prefix 'INS'. They both carry the same digits to indicate additives. For example, acetic acid is codes E 260 and INS 260 in the two systems. . The list is updated on a regular basis and includes those additives that are Generally Recognized as Safe (GRAS). The nutrients added to foods are not included in the E system. The INS system is boarder than E system, and it is intended as an identification system for food additives.

Food additives can also be classified as preservatives, process aids, shelf-life extenders, and sensory improvers. Benzoic acids and its salts, propionic acid and its salts, sorbic acids and its salts, and sodium nitrates/nitrites are some common preservatives. The additives enzymes, pH regulators, clarifying agents, dough conditioners, and anti-caking agents are used as process aids. Additives considered as shelf-life extenders include antioxidants, humectants, emulsifiers, sequestrants (succinic acid and tartaric acid), stabilizers (alginates, gelatin, carrageenan, etc.) colorants, acidulants, sweeteners (sucralose, aspartame, sugar alcohols, etc.), and flavor enhancers are some subcategories of sensory improvers. All these additives are used in the food industry subject to regulatory limits linked with the additive and on specific foods.

Needs/Uses of food additives in the food industry

A major function of food additives is the preservation of food. Antimicrobials, antioxidants, and anti-browning agents are common preservatives. Salt is used on the home scale to preserve fish and lemon-like foods. The preservatives act against spoilage by microorganisms such as bacteria, yeast, and molds in foods. These additives can retain the freshness of foods while enhancing the shelf-life. Preservatives used to control microbial growth include organic acids and their salts, sulfites, nitrites, parabens, and others.The meat industry uses nitrates and nitrites (curing salts) in sausages and bacon-like meat-based products for preservation and stabilization of pink colour. Sodium or Potassium Metabisulphite (SMS/KMS) are used in fruit juices, and dried fruits, to suppress microbial activity and for preserving them.

Colorants are used to improve the existing natural color of the processed foods ensuring a more attractive product. This helps to retain the original colour in foods which tends to fade during processing. This is common with processed fruits like tomatoes and fruit juices. Heat or canning of foods also cause color losses. Sri Lanka has permitted the use of only 10 synthetic colours. The lists of permitted colours in other countries are different and carry a bigger variety. Of the synthetic food colours permitted in Sri Lanka, tartrazine and erythrosine are not allowed in some countries due to food safety concerns.

The flavoring agents are added to sweeten, alter (enhance) the existing taste, or change the final taste of the product. Sweeteners (sugar alcohols, sucralose, aspartame) are natural and synthetic flavors. The

sweetness index of some of the sweeteners is much more, allowing achievement higher sweetness with smaller quantities of additives. Monosodium Glutamate (Inosine 5' phosphate) is a flavour enhancer. Flavours of natural foods are due to a combination of 100s of constituents. Among them there are certain compounds identified as character specific compounds. Food industry use such flavours to develop new products with characteristic flavours.

The texturizing agents used as additives are emulsifiers and stabilizers. The texturizing agents modify the food products' overall texture or mouthfeel of foods. Emulsifiers can form a stable mixture of two immiscible substances. Emulsifiers are commonly used in bread, flour, confectionery, ice cream, margarine, chocolate, and dessert mixtures. Egg yolk is a natural emulsifier containing lecithin. Stabilizers help to preserve the structure of foods. Some stabilizers include alginates, gelatine, carrageenan, xanthan gum, guar gum, pectin, etc. Gelatine is used widely as a stabilizer in gelatine to yogurts, jelly, fruit juices, and ice creams. In yogurts, it prevents layer separation, and in fruit juices stabilizers prevent sedimentation.

The additives used as process aids make food processing easier. They are added either to an ingredient or during the production process. They do not contribute to the final product characters. Use of sulfur dioxide during the peeling and slicing of apples to inhibit browning, and chemical defoamers used to minimize foaming in foods high in fat content are common examples.

Besides the above-mentioned common uses, additives are also used for food enrichment . Nutrient enrichment of cereal/ bakery products, ensure required proportions of nutrients such as B-complex vitamins of thiamine (B1), riboflavin (B2), and niacin (B3), to be present in the final product after processing.

	Allergens in foods requiring declaration in the label prominently	Codex	USA	EU	Canada	Japan	Australia	England	Sri Lanka
1	Wheat, rye, barley, oats (due to gluten)	•	•	•	•	•	•	•	Sri Lanka Yet to be done
2	Crustaceans, crabs, prawns, lobsters & pr	•	•	•	•	•	•	•	
3	Egg and egg products	•	•	•	•	•	•	•	
4	Fish and fish products	•	•	•	•		•	•	
5	Peanuts, soybeans & products	•	•	•	•	•	•	•	
6	Milk and milk products	•	•	•	•	•	•	•	
7	Cashew, almond Walnut (tree nut kernels)	•	•	•	•		•	•	
8	Sulphate more than 10 mg/kg	•	•	•	•		•	•	
9	Sesame and sesame products			•	•			•	
10	Mustard and mustard products			•	•			•	
11	Celery and celery products			•				•	
12	Lupin and lupin products			•				•	
13	Molluscans and molluscan products			•				•	
14	Sulphur dioxide							•	

Figure 2: Food allergen requirements in labels in different countries as a measure to inform food safety to concerned persons

Why are there safe levels of food additives (Heath risk of additives)?

Additives are used only if:

- ❖ They do not cause safety concerns to the health of the consumer at the levels proposed
- ❖ There is a reasonable technological need
- ❖ Usage does not mislead the consumer

The safe use of food additives is essential because of the above reasons. The toxicity of permitted food additives is generally low, and the doses to be added are decided through research to establish safe concentrations. However, there may be chronic health risks at concentrations above the safety reference levels. There are rare situations of food additives causing reactions leading to diarrhea and allergies in sensitive persons. The food safety hazards associated with food additives arise when they are used outside the permitted concentrations and for foods which are not permitted to contain additives.

Safety concentrations of additives

Regulations, or the safe levels of additives, are designed to provide

much lower concentrations than shown to bring in adverse effects using human and animal models. The concentration of additives permitted should not pause any health risk to consumers. These regulations apply to both natural and synthetic food additives.

JECFA , is continuously engaged in assessing probable risks to human health from food additives using the epidemiological data generated Worldwide. The safe level of food additives is accepted as 'Acceptable Daily Intake' (ADI). The ADI is expressed on a body-weight basis, and that estimated amount of a particular chemical is safe for consuming daily over a lifetime without recognizable health risk. The WHO has used the uncertainty factor of 100. It is based on a 10-fold factor to allow for differences between animals and an average human being, and a further 10-fold factor to allow for differences between average human and sensitive subgroups (pregnant women, the elderly). Usually, food additives are permitted at ppm/ ppb concentrations, in foods.

How can consumers know about additives in food?

Food labels carry the information of all ingredients added to them (Figure 1). There is legislation in Sri Lanka governing the labeling system for food additives, requiring the E-numbers of additives to be included. The E-numbers are categorized into different groups:

- Coloring agents: 100 - 180
- Preservatives: 200 - 285
- Antioxidants: 300 - 321
- Texturizing agents: 322 - 495
- Acids, alkalis, flavor enhancers, and sweeteners & additives with various other functions: 500-1250

Therefore, if a person is allergic to a certain chemical, that person can read the food label and get an idea about consumption. Most countries require identification of allergens in foods, to allow an informed choice by the consumers. Globally accepted food allergens and their labelling requirements in different countries are given in figure 2.

Trend towards the safe use of food additives

Global trend today is to move towards minimally processed foods. It has led to preference for natural food additives over synthetics. Not all edible natural compounds are recognized as additives today. The technological improvements may find increased opportunities for use of natural additives providing an increased comfort to the consumers concerned on synthetic food additives. Nanotechnology can also be used to develop food additives such as encapsulating the additives, allowing for controlled release and increasing stability. Emerging food technologies would focus more on safe foods for better health.

Recommendations to the industry

Food additives play a significant role in the food industry due to their ability to improve food quality. Food additives, especially the preservatives are becoming more important in meeting increased food demands. Due recognition should be given to possible health effects, especially the risks with vulnerable groups in commercial use of food additives. It is not a case of abiding by regulatory requirements, but responsible decisions by industry to minimal use of food additives, which has a better impact in the society than the regulatory controls. When formulating a food product, the food manufacturers should adhere to the above "Principles when Using Food Additives" and avoid abuse of food additives.
Exercise due care in choosing food additives; add only the amount of permitted food additive which could serve the desired technological function to the food. Use of food additives should be knowledge based.

(The author acknowledges the use of many scientific publications in producing this document for educational purposes)

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Aflatoxins and food safety in Sri Lanka

Emeritus Professor Upali Samarajeewa

Introduction

There is much concern over the presence of aflatoxins in foods all over the world, as it causes cancer among human beings. There are reported incidences of deaths associated with consumption of heavily aflatoxin contaminated foods by malnourished groups of human beings. Aflatoxins are a group of compounds produced mainly by molds *Aspergillus flavus* and *Aspergillus parasiticus*. Foods stored under tropical storage conditions of high humidity and temperature, as well as agricultural products containing more than 12% moisture for more than a day or two without quick drying, and oil containing food crops harbor the aflatoxin producing molds readily. These molds appear yellow on the second day of growth and turn moss green by 5-7 days, by which time the toxins are produced and released into the food kernels. There is no method to remove aflatoxins inside the food kernels. The moldy kernels should be physically separated and discarded to avoid food safety hazards. There are more than 70 mold species producing more than 120 similar compounds. They are collectively called mycotoxins. All other mycotoxins are less harmful than aflatoxins. The discussion in this article is limited to aflatoxins. Among 17 compounds identified as aflatoxins, four compounds designated as aflatoxins B1, B2, G1, and G2 are produced more frequently and are of concern from the food safety stand point. In terms of chemical relationship, some of the reactions that have been tried to destroy aflatoxins in foods, as well as important biochemical reactions are presented in Figure 1.

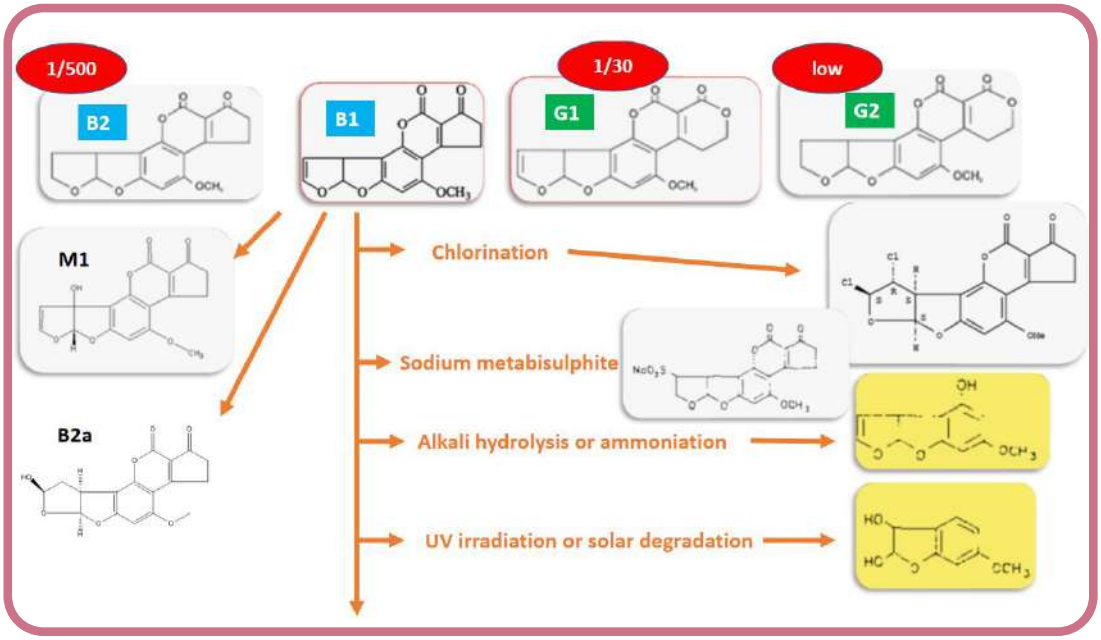

Figure 1: Chemistry and biochemistry of common aflatoxins

Of the aflatoxins shown in the figure, aflatoxin B1(AFB1) has been shown to have the highest carcinogenicity. The relative

carcinogenicities of the other aflatoxins are shown in red circles. When AFB1 is consumed by human beings or milking animals, it gets converted to Aflatoxin M1, which is of almost the same carcinogenicity as AFB1. In the human body AFB1 is converted to Aflatoxin B_{2a} which appears in urine. Many chemical reactions have been used in the attempt to destroy the aflatoxin molecules. Of these chlorine and sodium metabisulphite have shown some success. However, they bring in new food safety concerns when applied on food. Ammonia treatment was successfully applied to destroy aflatoxins in animal feeds. There were commercial units established in Pakistan and Tanzania to process animal feeds. However, the commercial destruction of aflatoxins could not be sustained because results were inconsistent. Ultra-violet radiation and the ultraviolet components of solar radiation are effective, but are applicable only to liquid foods as the radiation cannot penetrate through solids.

Figure 2: Mold growth on pepper, maize, chilies and peanuts during sun-drying

Aflatoxins in Sri Lankan foods

Peanut, maize, copra, and spices are the most common food items affected by aflatoxin contamination in Sri Lanka (Figure 2).

The growth of mycotoxin producing molds on food crops is dependent on the moisture content and storage temperatures (Figure 2).

Of the mold groups, aflatoxin producing molds could survive at lower concentrations gaining a competitive advantage under ambient handling and storage conditions.

The appearance during growth of *Aspergillus flavus / parasiticus* during storage, under laboratory conditions, and the sporulating bodies under the light microscope are shown in figure 4. Change of color from yellow to green due to production of spores corresponds with high aflatoxin accumulation in crops.

Field conditions permitting aflatoxin accumulation

Aspergillus flavus and *parasiticus* occur commonly in the soil, and the mold spores could get into air. This allows the growth and entry of the molds to food crops at different stages of development as described below.

Peanuts: Peanuts (groundnuts) are grown underground attached to the root system of the plants growing on loose soil. If the peanut pods

Table 1: The temperature and moisture regimes in crops that promote mold growth after harvest

The group of molds	Limiting moisture %	Growth temperature range °C
Aspergillus species	12	0 to 55
Penicillium species	17	-8 to 55
Fusarium species	22	5 to 60
Thermophilic molds	18	15 to 70

get damaged at harvest there is a high possibility of mold entry into the pods. Once inside the pods molds grow on the kernels. After harvesting by pulling out the peanut plants from ground, they are left in the field for sun drying. Humid air or rain during the drying period enhances mold growth on the kernels. The wholesome peanuts are more resistant to mold growth than shrunken and immature nuts. Removal of molds from surface of contaminated nuts does not guarantee food safety, as aflatoxins are already deposited inside the kernel by the hyphae growing into kernels.

Maize: Contamination of maize cobs occurs by the mold spores entering through the silk at the tip of the cob. Molds may also enter through the damage caused to kernels during drying. Maize is harvested at 17% moisture content to minimize the opportunities for growth of molds. Sun-drying of grains over several days provide adequate time and moisture for the molds to grow and produce aflatoxins. Mechanical drying immediately after harvest to reduce the moisture below 12% is the best way to avoid mold growth.

Spices: Spices can contact soil at harvest as no precautionary measures are taken. Such contact gives the opportunity for the mold spores to get at the spice kernel surfaces. Nutmeg and pepper are highly susceptible to mold growth during slow drying under the sun. Keeping the spices packed in bags at night enhances mold growth due to increase in moisture resulting from respiration. Molds grow inside the chili pods during growth. Sri Lankan researchers have developed chili varieties resistant to growth of aflatoxigenic molds. Rapid mechanical drying is the solution to prevent aflatoxins.

Copra: Copra gets contaminated at storage if the moisture content is above 6%. Copra is expected to be smoke dried to reach the 6% moisture concentration. It does not happen most of the time. At storage for months, the copra kernels absorb moisture from the atmosphere favorable to mold growth. Immediate extraction of oil from smoke dried copra would avoid aflatoxins in coconut oil and poonac. Sun-drying of copra at domestic level provides increased opportunities for molds to grow as the rate of drying is slow, being only during sunny hours. Of the aflatoxins produced in copra 2/3 pass into coconut oil.

Under experimental conditions many foods and raw materials have been shown to facilitate growth of molds and for accumulation of aflatoxins.

Animal feeds are prepared using raw materials that include coconut poonac, gingerly poonac and the waste by-products from beer fermentation. These raw materials contain high concentrations of aflatoxins. The aflatoxins appear in the milk as aflatoxin M1.

Prevention and control of aflatoxins for food safety

The most effective way to ensure aflatoxin free foods is to prevent mold growth through rapid drying of crops and minimizing storage period before secondary processing. Controlling humidity and temperatures coupled with forced ventilations to remove moist air from storage spaces help in minimizing mold growth. Physical separation of contaminated kernels help in avoiding rejection of foods in trade due to mycotoxins. Figure 5 shows manual separation of contaminated peanuts and faulty spices at processing to ensure food safety.

Heating of foods commercially or during home preparations cannot destroy the aflatoxins adequately to ensure food safety. The percentage

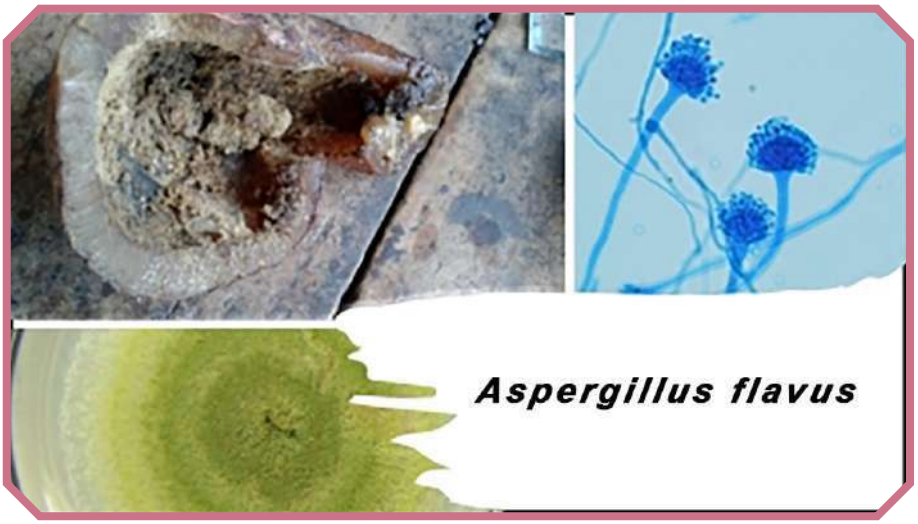

Figure 3: *Aspergillus flavus* and *parasiticus* under field and laboratory conditions

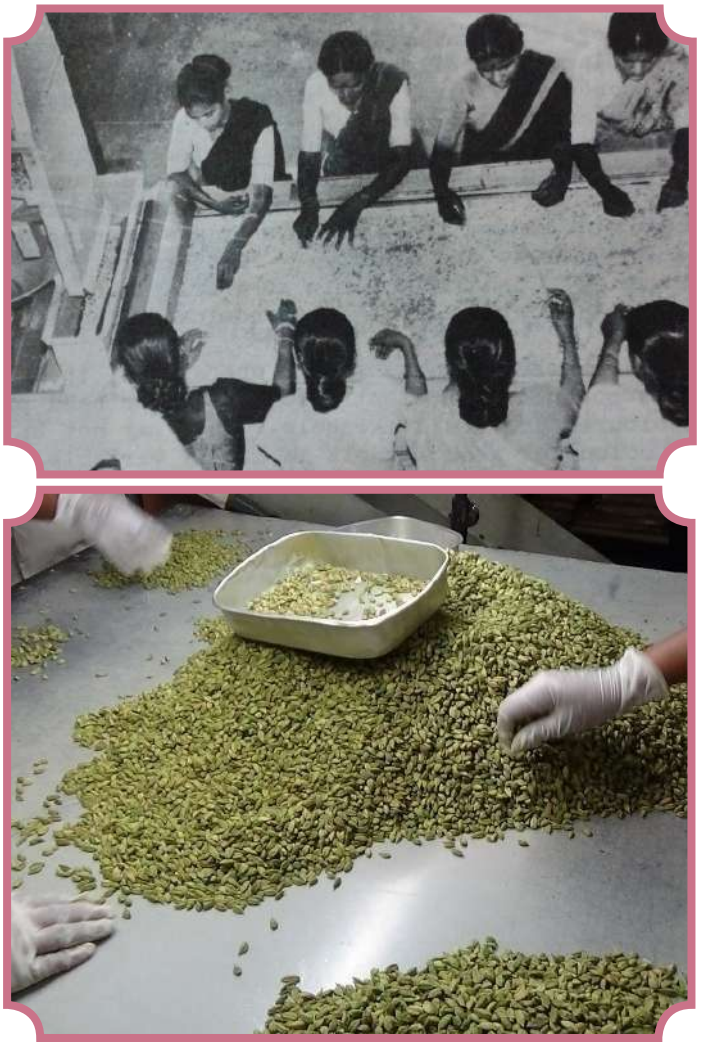

Figure 4: Separating the moldy kernels between processing and marketing to avoid rejection of the entire produce

of destruction is shown in table 2.

The information in the table 2 indicates that food safety cannot be achieved through heating of foods to destroy aflatoxins.

Aflatoxins in coconut, peanut and corn oils are major food safety problems in developing countries. Physical refining of edible oils does not help in adequate removal of the aflatoxins from heavily contaminated oils. In physical refining, a limited quantity of aflatoxins may be adsorbed by the agents used to remove the pigments in oils. Chemical refining of oils remove the aflatoxins as sodium salts during the aqueous washing phase. The effects of physical and chemical treatments on two samples of aflatoxin contaminated peanut oil are shown in figure 5. Even at very high concentrations of aflatoxins in oil, 92% and 98% removal of toxins to ensure below legal tolerance limit of 10 µg/kg is achieved through chemical refining. Physically refined oils described as RBD (refined, bleached, deodorized) oil does not ensure food safety from aflatoxins.

The presence of aflatoxins is a major food safety hazard associated with coconut oil produced from contaminated copra. This problem is associated with both local and imported coconut oils. Among local coconut oils, the oils expelled using small expellers from sun dried copra remains the major hazard, as the aflatoxin concentration in such oils are much higher than those produced in commercial mills. The coconut industry needs to move away from the production of coconut oil from smoke-dried copra, to expulsion of oil from mechanically (oven) dried coconuts. Contamination does not occur in coconut oil. The

Table 2: Percent destruction of aflatoxins on heat processing or cooking

Heat sensitivity of aflatoxins

Melting point 260 °C; Heat decomposition occur at 269 °C

Food	Temperature /Energy - time	% loss
Peanut oil	120 °C; Minutes 10	50
Cooking, peanut meal	100 °C; Minutes 60	66
Baking bread	120 °C; Minutes 30	80
Deep frying	190 °C; Minutes 6	60
Microwave peanuts	Kw 6; Minutes 4	95
Microwave peanuts	Kw 0.7; Minutes 9	50

problem arises at the kernel drying and storage stages.
The ability of solar radiation to breakdown aflatoxins to non-toxic products could be carried out home level by exposing coconut oil in the form of a layer of 4 cm in a flat bottle to sunlight for 60 minutes. The rate of breakdown of aflatoxin on exposure to sunlight, and the way to practice it are shown in figure 6 below.

The best option is to expose all coconut oil for 1 hour after purchase to sunlight. Though the action of sunlight may increase the acidity of the oils slightly, the resulting acidity does not cause a food safety hazard.

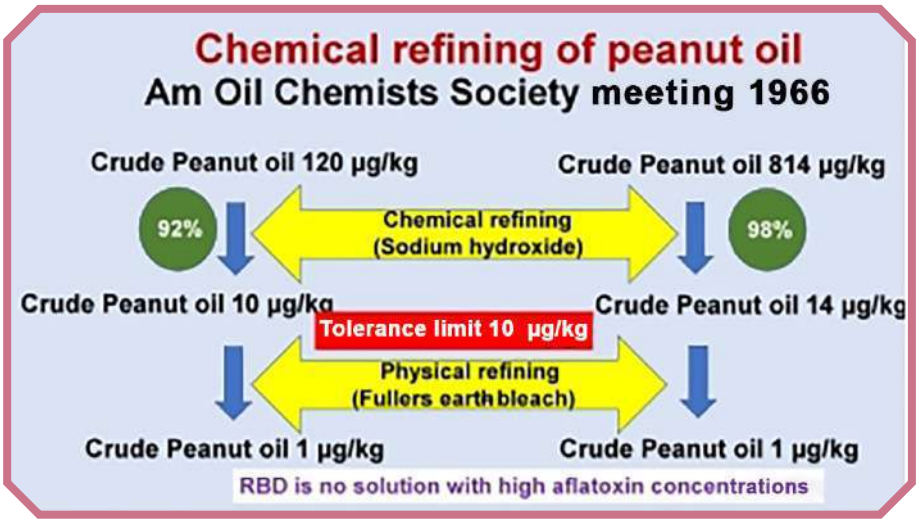

Figure 5: Effect of physical and chemical refining of peanut oil on aflatoxins

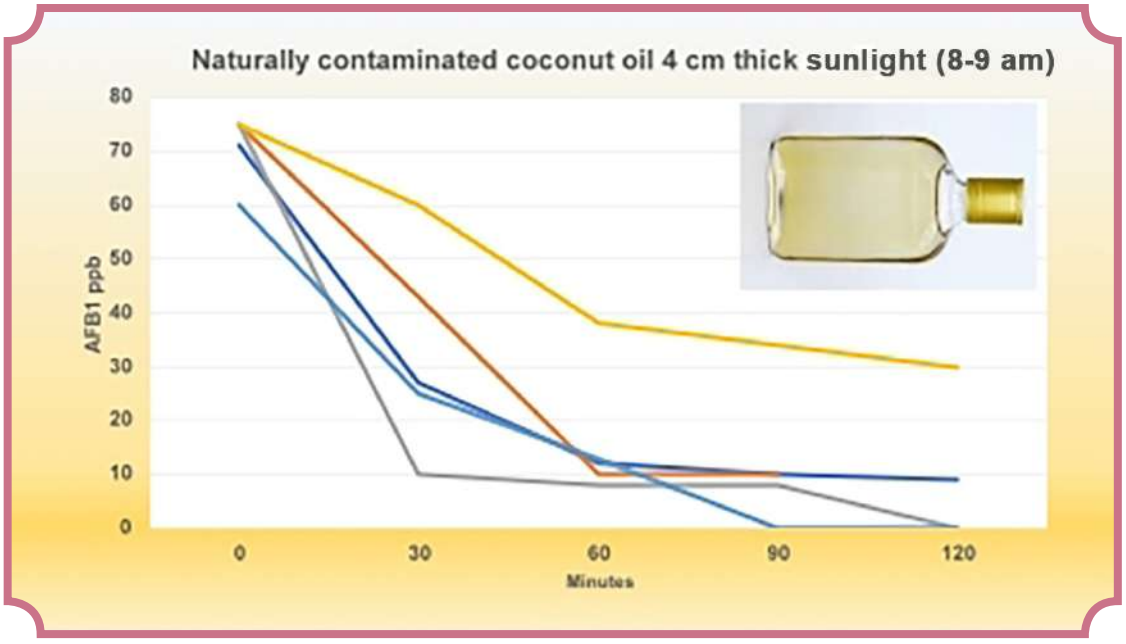

Figure 6: The rate of breakdown of attatoxin on exposure to sunlight

(The author acknowledge the use of many scientific publications in producing this document for educational purposes)

Conclusion

Aflatoxin being a class 1 carcinogen, there is much concern to control it in foods aiming better health. All efforts must be taken to prevent the growth of molds on foods after harvest to minimize food safety hazards.

Recommendations

1.Separate all moldy food kernels before processing
2.Minimize storage period, and the moisture percentage in foods to prevent mold growth
3.Expose coconut oil to sunlight for 1 hour in a flat bottle once immediately after purchase as a precautionary measure.

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Polycyclic aromatic hydrocarbons in foods and safety concerns

Dr Rasangi Sabaragamuwa

Introduction

The association of human cancer on exposure to dust from chimney smoke dates back to 1775, with the observation of Percivall Pott on scrotal cancer among persons, who carry out cleaning of chimneys of houses (Figure 1). In 1930, this cancer was proved to be due to contamination of the skin by chimney soot containing polycyclic aromatic hydrocarbons (PAHs).

Situations similar to smoke deposition in chimneys of heating systems of homes during winter in cold countries, could be present to a certain degree in the traditional firewood kitchens in Sri Lanka, where PAHs are in the air, and deposited on surfaces inside. People can get exposed to PAHs from the air and the soot in the kitchen.

PAHs are a group of organic compounds containing two or more aromatic rings in their structure. The PAHs are of natural or anthropogenic origin, produced by pyrolysis or incomplete combustion at elevated temperatures, reduced oxygen levels, and burning organic matter. Such combustion yields a complex mixture of PAHs, which may accumulate in the environment; water, air, soil and foods. The food safety hazards due to PAH occur mostly from the generation of PAHs within foods during heat processing. The PAHs are divided broadly as light PAHs (LPAHs, 2–4 rings), occurring in the atmosphere in the vapour phase, and as heavy PAHs (HPAHs, more than 4 rings), bound to particles.

Figure 1: Steps in the food chain and the points of entry of harmful ingredients to foods leading to food safety hazards.

Individual PAHs vary in their ability to cause cancer and toxic effects on the chromosomes of the human genes. Of the PAHs, 16 compounds have been identified to be of high relevance to food safety by the Environment Protection Agency of United States of America. Their classification based on carcinogenicity, structural features and the terminology used to discuss them are given in table 1.

Of the PAHs listed above, Benzo[a] pyrene (BaP) is of the highest carcinogenicity, and it is used as the marker in discussing food safety hazards associated with exposure to PAHs. The PAHs are also grouped

Table 1: The PAHs commonly identified in foods, their carcinogenicity and structural features

Name [Abbreviation]	Genotoxicity	IARC classification	Rings	Sum
Acenaphthene	questionable	Not evaluated	2	
Acenaphthylene	questionable	Not evaluated	3	
Anthracene	negative	3 (Not classifiable)	3	
Benzo(a)anthracene [BaA]	positive	2B (Possibly carcinogenic)	4	8, 4
Benzo(b)fluoranthene [BbF]	positive	2B (Possibly carcinogenic)	5	8, 4
Benzo(k)fluoranthene [BkF]	positive	2B (Possibly carcinogenic)	5	8
Benzo(g,h,i)perylene [BghiP]	positive	3 (Not classifiable)	6	8
Benzo(a)pyrene [BaP]	positive	1 (Carcinogenic)	5	8, 4
Chrysene	positive	2B (Possibly carcinogenic)	4	8, 4
Dibenzo(a,h)anthracene [DBahA]	positive	2A (Probably carcinogenic)	5	8
Fluoranthene [F]	positive	3 (Not classifiable)	4	
Fluorene	Negative	3 (Not classifiable)	3	
Indeno(1,2,3-cd) pyrene	positive	2B (Possibly carcinogenic)	6	8
Phenanthrene	questionable	3 (Not classifiable)	3	
Pyrene [Py]	questionable	3 (Not classifiable)	4	
Naphthalene	positive	2B (Possibly carcinogenic)	2	

for scientific discussion, as taking together four compounds of the highest toxicity as sum of 4 (Σ_4) or sum of 8 (Σ_8) considering second level of toxicity. The total number of PAHs of interest to food safety discussions is designated as Σ_{16}.

PAHs are formed during barbecuing, grilling, roasting, smoking, drying, baking, frying, and toasting due to the action of heat mainly on the fatty constituents of the food. In coconut oil, the formation of PAHs begins around 60 ºC on heating. In the manufacture of virgin coconut oil, the temperature is kept below 55 ºC using a cooling water jacket around the expeller to prevent the generation of PAHs (Figure 2).

Occurrence of PAHs in food

Raw food usually do not contain significant concentrations of PAHs, unless contaminated by environmental pollutants including firewood smoke, motor vehicle exhaust gases, burning tyres, and tobacco smoke.
As mentioned earlier, the processing of food (such as drying and smoking) and the cooking of food at elevated temperatures (grilling, roasting, frying) are major sources for generating of PAHs. PAHs have been found in a wide variety of foods including smoked meat and fish, barbecued meat, and unrefined vegetable oils. Concentrations found in food tend to be linked to the amount of fatty tissue, temperature of treatment, and duration of heating. In Sri Lanka, the following PAH concentrations have been published in the Journal of the National Science Foundation in 1996 for coconut-based foods (Table 2).

The table indicates the contamination of coconut products due to heat and smoke deposition

Figure 2: Food preparations leading to production or deposition of PAHs in foods

during processing. The PAH concentrations in copra reflects what is deposited by smoke and in coconut oil and pairings oil represent what is generated during expulsion of oil in addition to what is deposited by smoke.

Processing and cooking procedures are commonly thought to be the major source of contamination by PAHs. The PAHs are formed on food depending on several parameters, which include time, type of fuel, distance from the heat source and drainage of fat, and the method of cooking (grilling, frying, or roasting).

Grazing cattle and poultry may ingest particulate matter from soil contaminated by heavy PAH adsorbed particles. The light PAHs may be adsorbed to waxy surfaces of vegetables and fruits due to lipophilicity of PAHs. PAH concentrations are generally higher on plant surfaces (peel, outer leaves) than in the internal tissues. However, thorough rinsing may remove up to 50% of the total PAH on vegetable surfaces. Particle bound PAH are easily washed off the surfaces, whereas those in the waxy layer are less efficiently removed.

PAHs could be present in processed foods at varying concentrations based on the environmental and processing conditions. Some of the foods reported to carry PAHs in other countries are summarized in table 3.

The information in the above table indicates that the origin of PAHs could be from many sources. The practices that lead to heavy generation or accumulation of PAHs in foods are shown in figure 2.

Where deposition of PAHs occurs on surface of foods, it would mostly be in the outer layer. In Maldive-fish (Umbalakada) produced by smoke-drying of fish dipped in boiling saturated salt solutions contain PAHs deposited from smoke in the outer 2 mm layer.

Human health and safety concerns

In addition to ingestion through food containing PAHs, exposure to PAHs can occur from inhaling air, smoking cigarettes, or breathing smoke from open fireplaces. It is apparent that PAH exposure to human beings occurs on a regular basis from the environment and from food sources. Due to the high lipophilicity of this class of compounds, their bioavailability after ingestion and inhalation is significant. Research has shown the presence of detectable levels of PAH in almost all internal organs of animals and human beings, especially in organs rich in adipose tissue.

The impact of PAHs on human health will depend on the length and route of exposure, the amount exposed to, as well as the relative toxicity of the exposed PAHs. Short term health effects such as nausea and vomiting has also been reported due to exposures. However, the major concern is on the long-term health effects arising from the carcinogenicity of these compounds.

The reactive metabolites, such

Table 2: PAHs observed in coconut products in Sri Lanka

Product	BaP µg/kg	Σ16 PAH µg/kg
Fresh coconut kernels	0	0
Copra	3	102
Coconut oil	12	359
Poonac	1	68
Desiccated coconuts	1	11
Virgin coconut oil	0	0
Coconut parings oil	5	109

Table 3: Summary of PAHs reported in foods from different countries

Food product	Σ16 PAH range µg/kg	Food product	Σ16 PAH range µg/kg
Milk	5.4 - 147.2	Sugar	0.1 - 4.0
Cheese	0.2 - 1643.2	Salt	0.3 - 7.0
Milk powder	11.8 - 78.4	Honey, chocolate	0.2 - 235.9
Yogurt	7.12 - 12.8	Tea and Coffee	3.8 - 3091.1
Butter, margarine etc.	1.7 - 21.7	Vegetable oils	0.6 - 234.3
Processed fruits vegetables	1.1 - 335.7	Infant formulations	0.1 - 2.54
Processed cereal products	0.6 - 880	Alcoholic beverages	0.2 - 172.3
Eggs	49.6 - 496.3	Fish oils	9.5 - 35.0
Chicken	1.1 - 31.7	Herbs	61 - 9001
Pork	0.2 - 34.7	Fish (include smoked)	1.6 - 1068.8

as epoxides and dihydrodiols of some PAHs have the ability to bind to cellular proteins and DNA. Such binding results in biochemical disruptions and cell damage causing mutations, development of malformations, tumors, and cancer. Further, immune suppression effects, genotoxicity and teratogenicity effects have also been evident in animal experiments with PAHs.

Strategies to reduce exposure to PAH

Good practices and strategies to reduce formation or removal of PAHs are important steps to avoid health risks due to ingestion of these compounds. The Hazard Analysis and Critical Control Point (HACCP) systems addressing food safety management in food industries, can assess the likelihood of PAHs being present, introduced, or developed in the manufacturing process, and the application of controls that are in place, it is possible to PAH in foods.

At the industrial level of processing, redesigning the operations to minimize PAH formation is possible. The modifications introduced commercially to the virgin coconut oil production (figure 3) process is a success story. Measures should be taken to minimize contamination of food with PAHs from smoke and direct drying processes.

Considering the exposure levels under Sri Lankan conditions to PAHs, recommendations have been made to Sri Lankan food authorities by the Institute of Food Science and Technology Sri Lanka, to consider the following tolerance limits in drafting regulations (Table 4).

Further, practices at domestic level such as thorough washing and/or removal of outer peels of fruits and vegetables, marination with condiment and spice mixtures which reduces PAH concentrations, use of alternative cooking methods (cooking at lower temperatures, exposing the lean portion of the meat during grilling, avoiding direct contact of the food with the flames during barbequing,

Figure 3: Water jacketed oil expellers used for virgin coconut oil to prevent formation of PAHs

Table 4: Proposed tolerance limits for PAHs for foods in Sri Lanka

Foods	BaP µg/kg	Σ4 PAHs µg/kg	Notes
Chemically refined coconut oil	2	10	Chemical refining removes all PAHs in the oil totally
Virgin coconut oil	2	10	Extraction of virgin coconut oil is done at temperatures below 55 ºC to prevent formation of PAHs
Crude coconut oil	10	50	Expulsion leads to formation of PAH at the screw press operating around 140 ºC
Coconut parings oil	10	50	Expulsion leads to formation of PAH at the screw press operating around 140 ºC
Foods fried using edible oils	5	10	Fraction of PAHs would be absorbed into foods during frying.
Vegetable oils	2	10	Imported oils are expected to be chemically refined
Palm oil	2	10	Edible palm oils need to be chemically refined
Desiccated coconut	2	10	There is no deposition or production of PAHs in the process
Food for children and sick using roasted rice	2	10	Minimize over-roasting of rice.
Spices (whole or powdered)	10	50	They are not smoke dried and used in small quantities in foods
Tea (Black)	10	50	During kilning in the black tea process PAHs are formed. It needs to be checked.
Smoked fish	5	12	Smoke deposition itself and action of heat on fish oils produce PAHs
Smoked meat including smoke cured sausages	5	12	Smoke deposition itself and action of heat on fats in meat & meat products produce PAHs

and using electric or gas broilers instead of charcoal etc.), irradiation, sun drying, reduction of smoke contamination used in the smoking process choosing combustible material, and use of appropriate packaging to absorb these compounds are recommended.

Poor production and preparation practices may result in human exposure to PAHs through foods. Creating awareness of consumers and processors on sources, and remedial measures, would be an effective strategy in the Sri Lankan context. Control of PAHs in food would ensure Food Safety for Better Health – The theme for 2022.

(The author acknowledges the use of many scientific publications in producing this document for educational purposes)

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Pesticide residues and food safety in Sri Lanka

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Introduction

The development of high yielding food crops to meet the growing food demand, resulted in concentrations of crop cultivation in selected areas without other plants in between. The concept is called monoculture as could be seen with coconut, tea paddy and vegetables. The nutrient rich foods available in plenty in the new plants attracted more pests (insects, molds and rodents) to live on them, defeating the purpose for which Sri Lanka plant breeders developed high yielding food crops. Weeds started competing with the food crops taking away the soil nutrients available for food crops. In these circumstances, it became necessary to check the pests competing with human beings for food, to prevent decreasing yields of the food crops. One of the mechanisms available to protect food crops for human beings was the application of chemicals toxic to pests. Though such chemicals can eliminate the pests, the chemicals also had harmful long-term effects on human beings resulting from exposure to small doses over years. The residues left in the food from these chemicals, their metabolites, and their reaction products are described as pesticide residues. Detection of the harmful nature of pesticide residues to human health through research resulted in prohibiting the use of certain pesticides. The pesticides allowed to be used in a country is decided based on the types of food crops, the climate that allows pesticides to survive, the positive effects of a particular pesticide on identified groups of pests, and the seasons or the durations for which the pesticides should be used on crops. While the residues left over in the food at harvest could affect human health, the health of farmers also may be affected due to inhaling pesticide contaminated air. Pesticides may also be absorbed through the skin of exposed persons.

Prevention and check to ensure food safety

There is continuing research on the presence of pesticide residues in food, and their potential harm to human health. Based on scientific data, the doses to be sprayed on food crops, as well as the timing for spraying of the pesticides are determined in relation to plant growth and time of harvest. Pre-harvest interval, which allows for pesticides to taper off from foods, making them safe for human consumption is an important guideline addressing human health through safe foods. Agricultural authorities and the Office of the Registrar of Pesticides provide guidance to farmers on the doses, timing and pre-harvest interval for each pesticide in relation to vegetables, fruits and grains. Each pesticide is tested for the residual concentration of the active ingredient present before scientific approval for sales. Guidance include preparation of pesticide solutions for spray and the quantities to be sprayed into a unit area of land holding the crops. It is a social responsibility of the pesticide sellers and the farmers to strictly follow the guidelines issued by the relevant agricultural authorities. The precautions and protective measures at spraying of pesticides are shown in figure 1.

After spraying a pesticide on a food crop, the constituents of the pesticides may be converted

Figure 1: Spraying on the plants avoiding air pollution and wearing protective clothes are two important aspects in applying pesticides

to other compounds, and consequently the concentrations on the food may decrease with time. There are strict guidelines on the time gap that should be maintained between the time of spraying pesticides and the time of harvest of the crops. The time gap is called pre-harvest interval. The guidance described above aims in assuring food safety from pesticide residues in vegetables, fruits and grains available in the market.

The public health problems that may arise due to pesticide residues in foods would not be visible immediately. They may appear after long periods of consuming contaminated foods. Production of safer foods for better health, thus lies with those advising the farmers and the farmers themselves. Food safety problems arise with the spraying of higher doses of pesticides or mixtures of pesticides sold under different trade names expecting better management of pests. Regulations and guidelines are required to prevent overuse of pesticides and to ensure food safety.

Regulations

There are more than 1000 chemicals identified as pesticides. The chemicals are marketed under different trade names by manufacturers. Each country selects the pesticides essential for its food crops. The Registrar of Pesticides has approved 58 pesticides to be used in Sri Lanka in the gazette No. 2023/34 dated 14th June 2017. As new evidence arise on unsafe pesticides, they are prohibited from time to time. The pesticides prohibited for use in Sri Lanka are listed in table 1.

For each of the pesticides permitted in Sri Lanka, the concentrations to be sprayed, the food crops on which they may be applied, and the pre-harvest intervals for each crop are listed. An example of the information from the gazette is given in table 2.

The tolerance limits for pesticide residues in foods vary among countries based on the degree of protection, each country wish to maintain, through safe foods for better health of the populations. In food export trade, importing country imposes specific regulations to be followed.

Presence of pesticides in foods in Sri Lanka

There are instances where pesticide residues beyond the MRL were detected in foods in Sri Lanka. Some of the reported incidences of pesticide residues are given in table 3.

There are similar reports on pesticide residues in imported fruits. What is important from a food safety point of view is to understand whether the residues in foods are above the tolerance limits described as Maximum Residue Levels (MRL) stipulated in the gazette notice described earlier. Testing for pesticide residues is expensive and time consuming. Therefore, the best solution is the adherence to guidelines on pesticide spraying, which is a responsibility of farmers and relevant organizations for providing instruction to farmers at the field level.

Table 1: Pesticides prohibited to be used in Sri Lanka and the year of prohibition

Pesticide	Year	Pesticide	Year
Endrin	1970	Aldicarb	1990
DDT	1976	Quintozene	1990
Chlordimeform	1980	Pentachlorophenol	1994
Dieldrin	1980	Methamidophos	1995
Phosphamidon	1980	Monocrotophos	1995
Thallium sulphate	1980	Chlordane	1996
2,4,5-Trichlorophenoxyacetic acid	1984	Endosulfan	1998
Ethyl parathion	1984	Paraquat	2010
Methyl parathion	1984	Dimethoate	2010
Aldrin	1986	Fenthion	2010
Lindane	1986	Cyromazin	2010
Hexachlorocyclohexane	1987	Alachlor	2011
Mercury compounds	1987	Carbofuran	2013
Arsenic compounds	1988	Carbaryl	2013
Heptachlor	1988	Chlorpyrifos	2013
Leptophos	1988	Propanil	2013
Captafol	1989	Glyphosate	2015
Dichloropropane	1990		

Pesticide residues and public health

Pesticides can interfere negatively with functioning of the nervous system, respiratory system and the cardiovascular system of human beings. It is therefore important to monitor their presence in foods regularly, and their appearance in urine indicating food safety hazards.

A study conducted by the World Health Organization in 2013, examined the presence of pesticide residues in foods and in the tissues of people in the North Central region of Sri Lanka, to identity those suffering from Chronic Kidney Disease of Unknown origin (CKDU). This study detected 2,4-D, 3,5,6-trichloropyridinol, p-nitrophenol, 1-naphthol, 2-naphthol, glyphosate, and amino methyl phosphonic acid in 33%, 70%, 58%, 100%, 100%, 65% and 28% of samples tested respectively. Some of the compounds reported above are not the pesticides appearing directly in the urine, but their breakdown products generated during metabolism. The report also indicate the presence of pesticides 2,4-D, Pentachlorophenol, Chlorpyrifos, Carbaryl, Naphthalene and Glyphosate at concentrations above reference levels (above expected safety levels) in 3.5%, 1.7%, 10.5%, 10.5%, and 3.5% of urine samples respectively. It has also to be noted that some of the pesticide residues

Table 2: The food crops for which pesticides are recommended, the pre-harvest interval and permitted maximum residue limits (MRL).

Pesticide	Food Crops	Time limit in days before harvest	MRL mg/kg of produce
Abamectin	Potato Beet Root Chilli Pepper	14 07 07	0.01 0.01 0.02
Acephate	Rice	14	1.0
Acetamiprid	Brinjal Okra Potato	14 14 14	0.2 0.2 0.03
Azoxystrobin	Grapes Banana Cucurbits including Bitter gourd, Snake gourd & Ridged gourd	14 14 14	2.0 2.0 1.0

Table 3: Pesticides whose residues were detected in foods in Sri Lanka.

Type of Crop	Pesticide detected
Vegetables (Brinjal, Okra, Cabbage, Capsicum etc.)	Abamectin, Acetamiprid, Antracol, Carbaryl, Carbofuran, Chlorantraniliprole, Chloropyrifos, Diazinon, Etofenprox, Mancozeb, Oxyfluorofen, Phenthoate, Polyram, Profenofos, Prothiofos, Tebuconazole.
Cereal crops (Rice), Fruits (Guava, Grapes, Pineapple, Mango)	Chlorpyrifos, Profenofos, Diazinon, Difenoconazole, Bifenthrin, Profenophos, Dimethomorph.
Green Leafy Vegetables (Gotukola, Kankun, Sarana etc.)	Carbofuran (After 14 days), Chlorothalonil, Profenophos, Novaluron, Metalaxyl.

detected in urine, should not have been present, as they are not permitted to be used in Sri Lanka.

The evidence on pesticide residues from the vegetables and other foods tested, and their breakdown products suggest that there is exposure of human beings to concentrations above the expected safety levels in foods.

Recommendation

❖ The organizations responsible in educating farmers, the pesticide sellers, and the farmers themselves can follow the information and guidelines pointed out in this document in spraying of pesticides on crops to ensure better health through safe foods.

❖ Sri Lanka needs to expand pesticide testing facilities, and undertake regular monitoring of pesticide residues in market foods.

(The author acknowledge the use of many scientific publications in producing this document for educational purposes)

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Packaging foods for safety

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Introduction

Foods become unsafe for human consumption due to the entry of microorganisms from the atmosphere, through contact with other objects or hands of handlers. The storage of foods beyond the expiry date also carry the tendency to create food safety hazards, especially in meat and fish stored at low temperatures. Microorganisms may grow and reach high populations with time, leading to food safety hazards. Exposure of food to the environment leave room for dust, and other solid particles to get deposited on the foods. The atmosphere may contain toxic gases produced during burning of fuels and other sources of energy. Burning of fuels and the vehicle emissions generate polycyclic aromatic hydrocarbons, some of which carry the potential to cause cancer. Protecting food against entry of various unacceptable constituents is an important requirement on ensuring food safety for better health. Packaging protect the food during transport, storage and at marketing, from the environment.

In trade, food packaging is primarily expected to help the consumer with the convenience of transport and handling them. Secondly, packaging helps the consumer by providing the required information through labelling. The label provides a description of the food, its shelf life or expiry date, and nutritional information. The shelf life of a food informs the consumer on the duration of safety associated with foods, especially in case of perishables such as meat and fish. The labels also carry information of storage conditions to retain its quality and safety. In the global food trade, food packaging is important to ensure protection and ensuring food safety. At the same time food packaging brings in concerns such as migration of unacceptable substances from the packaging itself to the food. The concept of food grade packaging became a part of the food industry to gain consumer confidence of food safety through selection of safe packaging materials. Advanced packaging technologies has enabled the production of Smart Packaging, capable of indicating to the consumers, the level of quality and remaining shelf life of a food. The objective of this article is to discuss the overall food safety benefits of food packaging, and impact of food packaging on the food.

Packaging materials for foods

A variety of food packaging materials are available for the food manufacturers. They are glasses, plastics, metals, paper boards, waxes, biodegradable materials and ceramics. Multi-layered packaging consisting of paper and aluminium with several types of plastics facilitate various processed food requirements, especially for marketing. While packaging material such as glass, metal, and plastic have excellent barrier properties against microbial, chemical and physical contaminants, paper might support exposure of the food to microbial contamination unless safely stored, transported and handled. Paper carton containing a ready to eat meal may not provide the expected protection if the carton is exposed to high moisture and as a result loses its barrier properties. In Sri Lanka, the use of food packaging material is regulated by the Food (packaging materials

and articles) Regulations 2010, under the Food Act No 80.

Migration of packaging constituents to food

Foods come into contact with the packages, leaving a room for constituents in the packaging materials to move into foods. Sri Lankan regulations on food packaging material and articles (Regulations 2010) stipulate that a food packaging material should not be used, if the material is injurious to human health, deteriorates the organoleptic characteristics of the food, or changes the nature, substance and quality of the food. Worldwide, food regulatory bodies have issued guidelines on specified maximum migration levels (SMLs) for those migrating particles (migrants). The constituents that may migrate into foods depend on the composition of the packaging materials. The Food (packaging materials and articles) 2010 regulations specify that packaging material should not impart Antimony (Sb), Arsenic (As), Cadmium (Cd) or Lead at a level higher than 0.2 ppm to a food product.

Glass packaging and food safety

Glass packages or bottles are made of silica. Silica is inert and does not impart toxic materials to foods on contact. All glass packages require a lid, which is usually made of metal, cork, or plastic. The selection of lids for glass containers depend on the type of food packaged. If the packed food requires sterilization to eliminate microorganisms, gasket type seal need to be a part of the lid. The gaskets may be made from rubber or polyvinyl chloride (PVC). Glass containers are often used for filling beverages, and processed food such as jams, jellies, cheese spreads and pickles. Glass provides a high degree of food safety as there is no release of harmful ingredients into food, though there is a high tendency for damage, if improperly handled.

The harmful migrant known in glass packaging is lead (Pb), though rare. The sand (silica) used for manufacturing glass may contain traces of lead. The caps in the

Table 1 – Safety of different plastics as food contact surfaces

Plastic code	Type	Safety as a food packaging material
Safe for use as food contact materials		
1	Polyethylene terephthalate (PET or PETE)	Long term storage of water and foods. No BPA. Used for soft drinks, juices, pickles, peanut butter and salad dressings.
2	High density polypropylene (HDPE)	Not recommended for drinking water. There are some modifications usable for long term food storage. Used for milk storage and to make food storage baskets.
3	Low density polyethylene (LDPE)	Less toxic than other plastics. Used to manufacture bags for bread, frozen foods and squeezable bottles for mustard etc.
4	Polypropylene (PP)	Less likely to contain unsafe chemicals. Used for yoghurt, margarine and medicines. Suitable to use under warm climates.
Unsafe for use as food contact materials		
5	Polyvinyl chloride (PVC)	Unsafe for use as food contact material. May contain lead and phthalates.
6	Polystyrene	Toxic styrene may leach from packages. Unsafe.
7	Produced by recycling of plastics	Unsafe. May contain Bisphenol A and other toxic materials.

glass containers may be plastics or gaskets made from rubber or polyvinyl chlorides (PVC). Common migrants of gaskets are

plasticizers such as phthalates and epoxidized soybean oil (ESBO). They may make the food unsafe. The migration of ESBO into food would be higher if the food contains fatty constituents such as processed fish, meat, and cheese. Food safety is ensured by preventing the use of PVC material containing more than 1 ppm vinyl chloride monomer. Presence of more than 0.05 ppm of vinyl chloride monomer makes the foods unsafe for human consumption.

Plastic packaging and food safety

Plastics as packaging materials are damage resistant and cost-effective compared with glass packaging. There are special food grade plastics for the purpose.

Plastic utensils are used commonly in preparation, storage and handling of food. In general, plastics may contain monomers and oligomers of PVC, and additives such as plasticizers, antioxidants, and heat stabilizers used in the manufacture of plastics. Presence of Bisphenol A (BPA) makes plastics unsafe for food storage. In packaging and transport of fruits, it is prohibited to apply coatings of vinyl chlorides on fruit's surface to retain freshness. The packaging used for fruits are required to be free of acrylonitrile plastics and materials from recycled plastics.

Of the diverse types of plastics available, only certain types could ensure the safety of foods. The plastic types suitable and unsuitable as food packaging are given in table 1.

Of the different types of plastics in the above table, only those in the categories 1, 2, 4 and 5 are safe for use as food containers and packages. Others may release toxic materials into food. The type of plastic could be identified by examining the number written in the bottom of containers within a triangle consisting of three arrows (Figure 1). Arrows indicate that the containers could be recycled. The symbol containing a wine glass and a fork shown in figure 1 indicate the plastic is suitable for use as food containers.

Suitable packaging materials to provide protection of foods and to be used as marketing tools are selected by food manufacturers from among the plastics discussed above. The plastic packaging materials used commonly for a few foods are shown in Figure 2.

Heating food in plastic containers in microwave ovens is not considered safe unless the container indicates that it is microwavable.

Metal packaging and food safety

Metal has been used as a food packaging since early 1900s. Metal packaging is widely used in fish and meat products, milk and other dairy product, processed fruits and vegetable products. Stainless steel coated with a thin inner layer

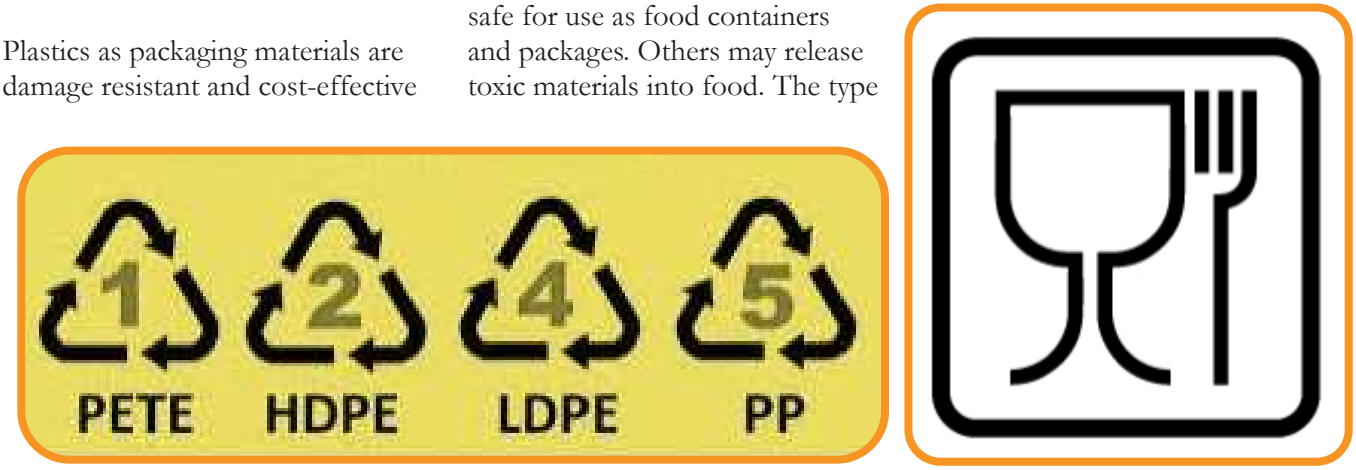

Figure 1: Symbols indicating plastic packaging and storage material safe for use as food contact surfaces.

Figure 2: Plastic packaging materials meeting food safety providing marketing advantages.

of tin, or an inner coating of lacquer (epoxy resins) is mostly used for food packaging. Damages to the inner protective layers in metal packages may transfer tin, lead, aluminium and chromium into foods on contact during storage in cans rendering foods unsafe for consumption. Epoxy resins could release extremely low concentrations of Bisphenol A, which is not considered a risk unless one consumes contents in 150 cans a day. Tin and lead migrate mostly from inner coatings of stainless-steel cans, but the concentrations are not considered hazardous. Concern and attention is needed in relation to the above food safety concerns in using food in metal cans.

Paper packaging and food safety

Paper packages come into contact only with solid foods. Two common harmful migrants in paper and paper board packaging are dioxane and benzophenone. Dioxane arise from the adhesives used in cardboards. The probable contribution from adhesive to packed foods is negligible to create food safety hazards. Benzophenone is a component in printing ink for the cardboard boxes. It is not considered to be present in quantities that could result in hazards through packed food. The papers and paper boards are made of either freshly processed cellulose or cellulose recovered from used paper material. With the use of multi-layer technology, paper packaging are developed to hold solid or semi solid food, and beverages. The paper board mostly forms the printable outer carton, which is not in direct contact with food in inner aluminium pouches. Paper is also used as a direct food contact material (FCM) when the paper is certified as Food Grade. Pizza is delivered in corrugated paper board boxes.

Wax has special applications in food packaging. Wax is applied on the outer surfaces of fruits such as apple, lime and lemon to retain moisture and discourage entry of microorganisms. Bee's wax and Soy wax are applied commercially on fruits for this purpose. They are not toxic. Paraffin wax is used to layer paper packaging to enhance the barrier properties of the paper. Wax layered paper may offer dual benefits. When dry food is packaged, the packaging may protect the food from environmental moisture. When moist food is packaged, the packaging may help to retain the required moisture and prevent undue drying.

Recommendations

Packaging of foods with appropriate containers need to be addressed as a mechanism for protecting foods from environmental contaminants. Selection of only the food grade plastics as containers for food uses as described above is essential to ensure safe foods for better health.

(The author acknowledge the use of many scientific publications in producing this document for educational purposes)

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Food safety in the Sri Lankan hospitality industry

Ms K. G. A. Omalka

Introduction

Sri Lanka is blessed with natural beauties and located in a strategic naval spot with major sea routes linking West Asia, Africa and East Asia. Sri Lanka entered the international tourism arena in the 1960s. Since then, tourism and the hospitality industry made a positive impact on economic development in Sri Lanka. The revenue generated through travel and the tourism sector contributes to four segments. Of the four segments of the hospitality industry identified below, the travel and tourism sector is a notable contributor.

1.Food and Beverages,
2.Travel and Tourism,
3.Lodging,
4.Recreation.

The Food and Beverage (F&B) sector is the main sector that determines the performance of the hospitality industry in Sri Lanka. The F&B services provide businesses delivering food and beverages to the customers. A key responsibility of the hospitality industry is to demonstrate that food is safe.

"Hygiene" is the key risk area in the hospitality industries, which is addressed seriously by all hoteliers. The commitment of hotels to hygiene standards in food preparation, and the physical safety of the guests stand high above other responsibilities. The confidence of the guests on hotel services is based on the quality and hygiene of food, kitchen, and the dining restaurants. In general, tourists appreciate the contribution of hotels in providing them with food safety and hygienic standards.

Food safety in catering

Food-borne illnesses have increased over the years negatively affecting the health and economic well-being of many developing nations. Food poisoning occurs on consuming food contaminated with chemicals, microorganisms or their toxins. Microbial contaminations arise from lapses in food preservation, unhygienic handling practices, cross-contamination from food contact surfaces, or from food handlers. Contamination of food may occur during large scale processing or during delivery to retailers. Food may get contaminated after preparation prior to serving the consumers.

Food safety is critical in the hospitality industry as prepared foods are more vulnerable to contaminations. Food handling in the hospitality sector need to manage the ingredients safely to reduce risk at the points of serving. Many star class hotels maintain high standards of hygiene and Good Practices to prevent outbreaks.

Challenges in the industry

There is a growing concern on food safety hazards in Sri Lanka with the expansion of the food industry along with urbanization, expanded tourism, increased trade in fresh and processed food, and increased consumption of foods of animal origin. Food safety risk management is important for public health and market development, both domestically and internationally. There are essential steps and specific practices to be taken to assure the safety of raw materials such as sea food, vegetables and fruits etc. through prevention of risks

associated with these raw materials in assuring food safety.

Hospitality industry has little control on safety of raw materials caused by pesticide residues, veterinary drug residues, and entry of pathogenic microorganisms at harvest and post-harvest. The industry needs to control these problems by purchasing raw materials that meet Sri Lanka Good Agricultural Practices standards on the quality and safety, and ensuring dedicated transport facilities.

Figure 1: Color coded chopping board system expected in restaurant food preparations

The hotels located in high traffic zones face the challenge of maintaining safe and hygienic environmental zones despite their limited space. This aspect needs to be considered in approving plans to construct buildings, and licensing of hotels, which is a responsibility of local authorities and the public health authorities.

Small food business operators lack infrastructure/ equipment such as refrigerators, food warmers, warm and running water, adequate kitchen space, etc. to ensure safe food. In developed countries and in successful tourist destinations such as Bangkok, these requirements are met prior to allowing small business operators, especially those engaged in preparing food in the locations of sale.

Water available for food preparations, is not potable making food prepared unsafe for consumption. However, availability of chlorinated water from the public system can do much to address food safety rather than the use of well water of unknown quality.

Low availability of qualified and trained kitchen staff to function, is a problem in the industry. There is a higher percentage of untrained and unskilled staff, with little knowledge of good hygiene practices and food safety regulations. It is the responsibility of the supervisory staff to ensure guidance and training of the untrained.

Storage of meat separate from vegetables is life-saving step in food preparation. Cross contaminations cause foodborne illness in the hospitality industry arising from use of the same cutting boards for perishable and nonperishable products. The best way to prevent cross contamination is to ensure the use of separate boards for meat, and foods that are to be served fresh (vegetables/ breads). There are six colors assigned for chopping boards. The colors relate to specific types of food (Figure 1). Many hotels use the color-coded chopping board system. However, it is not a legal requirement. It is an issue to be addressed by the certification bodies granting food safety management system certificates to the catering industry.

Food safety is reflected at the consumption stage, where the existence and the possibility of the dangers caused by foods are of chief concern. The adherence to rigorous control procedures throughout the food chain, is a fundamental requirement, given the fact that food safety can surface in any stage of the chain. The importance in the availability of reliable raw materials for the hospitality industry is a concern of the restaurants themselves. This aspect is clear in advertisement in a restaurant shown in figure 2.

Important leads to assure food safety in the hospitality industry

Hotel and restaurant premises include the buildings and rooms designed for food preparation and storage. They must be maintained clean. The design

Figure 2: Emphasis on good farming in getting raw materials for the catering industry as advertised by them

must provide adequate space for working and maintaining hygienic practices, prevent the build-up of dirt and mold, and provide a clean environment for handling and storage of food. There are standard plans proposed by the Codex system, and the local food control system for designing food preparation, storage and catering premises.

The premises should provide adequate:

i. Hand washing facilities and toilets for customers and staff
ii. Ventilation in kitchens and toilets
iii. Proper lighting
iv. Drainage for kitchens and toilets
v. Facilities for staff to change clothes
vi. Storage of cleaning chemicals, disinfectants and other chemicals
vii. One way food movement systems.

The design of food preparation areas in restaurants must allow good food hygiene practices and processes. It has specific requirements for food preparation areas relating to the condition and design of:

i. Floors should be constructed of a material that is easy to clean and safe to walk on and maintained in sound (undamaged) condition
ii. Walls should be made of durable impervious materials that are washable, non-toxic, easy to clean and maintained leaving no room for crevices, cobwebs and accumulation of dust.
iii. Ceilings and overhead fittings should be designed to prevent the accumulation of dirt, mold, condensation
   a) Windows must be constructed to prevent dirt accumulation and have insect screens where necessary.
   b) Doors should be easy to clean and constructed of non-absorbent material.
   c) Surfaces should be made of smooth, washable, non-toxic, corrosion-resistant material, and maintained in a good condition.
   d) Washing facilities for equipment and food must be adequate for washing food and utensils and have hot and cold water along with appropriate detergents where appropriate.

Food preparation equipments may harbor microorganisms and retain residues of chemicals. The equipment that contact with food must be made of appropriate materials, such as stainless steel 304 kept in good condition, cleaned effectively using recommended detergents, and fitted appropriately to allow cleaning around it. Use of plastic containers which do not meet "Food Grade" standards should be avoided.

Special attention need to be given to the use of water for food preparations, as water could be source of contaminants. The following guidelines address this aspect.

i. Water that comes into contact with food at cleaning, heating, steaming, cooling must be of drinking quality.
ii. Ice that comes into contact with food or drink, must be made with potable water and must be produced, handled and stored hygienically.
iii. Steam that comes into contact with food must not contain any contaminants that could affect food safety.
iv. Water that is used for non-food purposes, such as fire control, heating, refrigeration, must be kept in isolated systems so that it cannot contaminate food, drink, surfaces or equipment.

Food handlers come into close contact with food continuously. They could be carriers of pathogenic microorganisms without

their knowledge. It is therefore essential to create barriers between food handlers and food to ensure food safety in catering. Following guidelines are applied in working towards food safety.

i. Staff working in food handling areas must keep good personal hygiene. They should wear the protective uniforms designed for the purpose, and cleaned following planned procedures and timing.
ii. All raw materials and ingredients used in processing foods must be identified as safe and uncontaminated.
iii. Storage, processing and distribution systems must

protect food from contamination and cross-contamination to ensure food safety. This includes pest control and maintaining procedures that limit bacterial levels to within specified criteria.

Food waste tend to allow microorganisms to grow fast. Food waste need to be removed from the food processing tables as early as possible. It is recommended to remove food waste from the food preparation area within 2 hours and stored in bins with lids. The containers must be designed to be easy to clean, prevent contamination, prevent access to pests and kept in good condition.

Staff handling food must be instructed or trained in food hygiene, and supervised on their practices and adherence to guidelines. They are expected to report of possible contaminations arising from sicknesses among them and the family members. Vehicles used to transport food must meet thigh standards of hygiene, protection from contamination, and storage at suitable temperature. They must be kept clean and maintained in good condition. The vehicles engaged in transporting meat and fish should not be used for other purposes and should possess cooling systems. It applies to transport of milk too whether in bowsers or in small cans. Food safety could be achieved in the hospitality sector only by ensuring no room for cross contaminations and increase of microorganisms during transport.

Pests can threaten food safety by bringing in microorganisms and leaving their body parts and urine on foods. The food catering arm of the hospitality sector need to address this aspect as problems can arise without the knowledge of any body. There must be adequate measures to prevent pests from entering the premises. They may contaminate the utensils used for food preparations and the food both in storage and after preparation. Pest control measures need to be included into the planning of food preparation and storage areas both at the level of raw materials and prepared foods. The planned preventive measures include

i. Building design and maintenance to prevent access.
ii. Adequate storage of ingredients and prepared food under conditions that prevents access to pests.
iii. Hygiene measures to prevent access to food spills and waste that attracts pests allowing them to survive in the food environment.

The food safety system of hospitality sector involves numerous factors. Minimum hygiene standards must be maintained throughout. Official bodies committed to betterment of people must ensure that the regulations are implemented. Although factors jeopardizing food safety seems to be easy to control in theory, studies and current practices indicate that there is still a long way to go. There are many organizations in the hierarchy of the hospitality sector having mandate to promote tourism in Sri Lanka through several approaches. Also, according to the classification of entities in the hospitality industry, some exhibit inadequacies in performing food safety related functions. However, steps should be taken further to cover food safety objectives with practical recommendations to improve food safety in the hospitality industry.

(The author acknowledge the use of many scientific publications in producing this document for educational purposes)

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Veterinary drug residues and food safety in Sri Lanka

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Traditionally, animals were a part of the farmer life with a few animals kept in the home garden to get milk, eggs and meat. That was to fulfill the protein needs of the family and those of the neighborhood. Urbanization and the decreasing land area available for the animals to graze made it impossible to retain this cultural trait. Commercial farming became the option for production of milk, eggs, honey, and meat. Fish is harvested from the sea and inland water bodies with no commercial inputs. Commercial farming of prawns for export is done in the ponds in the coastal area between Negombo to Puttalam. There are farming units for eggs, meat and milk in Sri Lanka operating at small, medium and large scales.

In commercial farming, the animal flocks are herded in limited farming areas, facilitating the spread of diseases among them. The animals may be infected by bacteria, viruses, fungi, protozoa and parasitic worms. Parasitic worms may use the animals as a host to enter the human body. In commercial farming, growth promoting substances may be used to facilitate enhanced growth and thereby increase profits. Commercial animal farming is expected to be carried out under the guidance and supervision of veterinary surgeons, and veterinary inspectors at rural level. This is to protect animal health, and thereby produce safe animal-based foods. The diseases occurring among animals may spread directly to human beings or make animal-based foods unsuitable for consumption. Despite many checks and controls, some of the diseases that emerged among human beings were of animal origin. These include pathogens that originated in an animal or from products of animal origins, such as HIV-1 and -2, influenza virus, Ebola virus, and the coronaviruses. There are at least 13 diseases transmitted from the animals to human beings. Keeping farm animals free of diseases can therefore contribute

to human health directly. Ensuring the safety of animal-based foods is a necessity in maintaining good public health.

The use of veterinary drugs or medicines serve mainly two purposes in animal-based food production. Firstly, medicines prevent or cure diseases in animals. Secondly, they serve as nutrient supplements to improve health of animals, thereby increasing production and maintenance of the immune systems. The vaccines used on animals to strengthen their immunity against diseases does not come under the veterinary drugs.

The veterinary drug industry is as big as the pharmaceutical industry that produces medicines for human beings. There are more than 14000 chemicals identified as veterinary drugs in the World to maintain animal health. Of these, about 300 have already been withdrawn, while about 200 are considered illicit drugs. About 6500 are still under experimentation for their suitability and probable acceptability. Of the veterinary drugs, antibiotics are used widely to treat sick animals to prevent diseases among animals, while some others are being modified for physiological functions of animals. Antibiotics also help in improving the growth performance and efficient utilization of feeds among animals. Anti-helminth drugs are used to protect the animals from parasites.

Once a veterinary drug enters an animal body, it gets distributed in different proportions in the body organs. There is a tendency for higher accumulation or presence of them in the organs such as liver, kidney and fatty tissues. The amounts and types of edible components of animal origin consumed by human beings could vary. While most people consume muscles, others may prefer the liver, kidney, fatty tissues etc.

Prevention and checks to ensure food safety

The decisions on suitability of the animal-based products to be released for human consumption are made by the veterinarians. There are two aspects considered by them. Firstly, they check whether the animals are free of diseases at slaughter. Secondly, they monitor maintenance of Good Animal Husbandry Practices and Good Veterinary Practices to ensure unpermitted use of veterinary drugs, and unpermitted concentrations of the permitted veterinary drugs in edible tissues. After treating animals with veterinary drugs, there is a duration called 'withdrawal period' before which meat, milk or eggs from the treated animals should not be made available for human consumption. The implementation of the withdrawal period provides food safety assurance to the consumers. However, food safety could be confirmed only by laboratory testing, which is costly and time consuming. Sri Lanka is yet to strengthen the testing for veterinary drug residues to be practiced regularly.

Regulations

Each country maintains a list of permitted veterinary drugs and the tolerance limit for each drug for each type of edible animal tissue. Sri Lanka is yet to publish such a list. The veterinary drugs not permitted to be used in Sri Lanka are listed in the gazette No 1,292 of 06 June 2003. The list of unpermitted drugs are,

1. Nitrofurans
2. Dapsone
3. Ronidazole
4. Chloramphenicol - not under any veterinary label
5. Aminoglycosides - parenteral preparations - streptomycin, dihydrostreptomycin, neomycin, framycetin, gentamycin, spectinomycin.
6. Anabolic steroids as growth promoters
7. Antibiotics as growth promoters
8. Therapeutic antibiotics indicated for disease prevention.
9. Combination of antibiotics with vitamins, minerals, ions, amino acids, or similar products
10. Carbadox
11. Olaquindox

New prohibitions may be added to the list by the Veterinary Drugs Control Authority of Sri Lanka. Sri Lanka import meat and meat products from other countries. The products are not checked for veterinary drug residues but assumed to meet veterinary drug regulations of the exporting countries. There are internationally accepted certifications by veterinary health authorities or test reports generated by the accredited testing laboratories having memberships in the International Laboratory Accreditation system. It is important to check the authenticity of the certificates.

Presence of veterinary drug residues in foods in Sri Lanka

Researchers predicted the possibility of using antibiotics in 42 shrimp farms of the North-Western coastal area in Sri Lanka about 20 years back. Such practices may be still continuing. The World Health Organization (2005) had indicated the use of antibiotics oxytetracycline, tetracycline, amoxycillin, ampicillin erythromycin, oxalinic acid and sulphonamides in prawn farming in Sri Lanka. In a recent study, examined 129 market samples of poultry meat were examined for two antimicrobials, enrofloxacin and ciprofloxacin. The two antimicrobials were observed in 52% of the samples, where 3 specimens were found to exceed the tolerance limits established by the European Commission. While a high risk is not visible, the potential to create food safety hazards in the future cannot be ruled out unless regular testing systems are established.

In a screening study to check for the antibiotics in milk in Peradeniya area, 4 out of 30 samples had been found to contain antimicrobials. Bee honey is imported to Sri Lanka mainly to prepare the ayurvedic drugs. The author has observed residues of the antibiotic chloramphenicol, nitrofurans, trimethoprim, sulfathiazole, oxytetracycline, tylosin and tetracycline, and ciprofloxacin in the bee honey produced in a country planning to supply bee honey to European markets. Chloramphenicol and nitrofurans are totally prohibited from use. The bee-honey which cannot enter countries with strong regulatory systems, may find an easy outlet in Sri Lanka.

Table 1: Comparison of the regulatory standards established by Codex, European Union, Food and Drugs Administration of the United States of America and Canada Food Authority for veterinary drug residues in cattle muscle as a food (µg/kg).

Veterinary drug	Codex	EU	FDA	Canada
Albendazole	100	100	50	50
Amoxycillin	50	50	10	10
Chlortetracycline	200	100	2000	200
Fenbendazole	100	50	400	100
Gentamycin	100	50	No value	100
Neomycin	500	500	1200	500

While the above studies indicate the use of veterinary drugs, as well as their appearance as residues in animal-based foods, it is not possible to draw conclusions on the food safety hazards arising from them, unless detailed information on the presence of the veterinary drugs above the tolerance limit (MRL) are found.

With the development of nano-technology there will be new veterinary drug delivery systems, which may require new regulatory approaches and assessments of the risks leading to food safety hazards.

Figure 1: In some countries restaurant chains carry advertisements indicating that antibiotics are not used in the raw materials purchased by them to prepare food.

The maximum residue limits (MRL) of veterinary drug residues tolerated in animal-based foods differ among countries. A comparison of regulatory limits in four regulatory systems is given in table 1.
Variations in standards could be seen among different regulatory systems for the same animal organ. These differences reflect the balance between the levels of protection each country wishes to maintain for their populations, and the need to meet protein food security needs. Sri Lanka is yet to establish such regulations under the Food Act.

Veterinary drug residues and public health

The exposure of human beings to veterinary drug residues above the tolerance limit bring in new health hazards. Low concentrations of the antibiotics in animal-based foods may cause changes in the microorganisms naturally present in the human body, and may even lead to failed responses to treatment with antibiotics. In some countries, the restaurants make a special effort to attract consumers who prefer animal-based foods free of veterinary drug residues. The advertisement in the figure 1 reflect shows an effort.

Recommendations

Sri Lanka in its efforts to meet better health through food safety, need to strengthen the monitoring systems on the use of veterinary drugs, and testing of residues in animal-based foods. The first step towards monitoring lies in preparing regulations indicating permitted concentrations of the veterinary drugs in animal-based foods in the market. Achieving safety for better health not only requires scientific input from different disciplines but also the commitment of the authorities to make things happen.

(The author acknowledges the use of many scientific publications in producing this document for educational purposes)

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Regulating food safety for improved public health

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The World Health Organization (WHO) defines public health as "the art and science of preventing disease, prolonging life and promoting health through the organized efforts of society". Food is at the center of many critical public health issues, from hunger to obesity, chronic disease to climate change. Thus, food security becomes one of the determinants of improving public health. Food security exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for active and healthy life. Among other attributes of food security, food safety is one of the key areas of focus in public health, as contaminated food hampers socioeconomic development, overloads healthcare systems, damage economies, and negatively affects trade.

Along with food safety, food quality and food hygiene also play important roles in supplying food suitable for human consumption. Food safety, quality, and hygiene are not only an integral part of food security but also a public health priority. Food quality refers to dimensions that define the food product requirements or attributes that are necessary to meet consumer expectations for product integrity. Hygiene addresses the conditions/ practices that are conducive to maintaining health and preventing disease. Food safety addresses the need for a scientific discipline applying safe processes and practices to grow, harvest, store, transport, handle, prepare, and serve food and food ingredients, at all levels (farm to the consumer), to ensure food is free from hazards and prevent foodborne illnesses. Food safety hazards are substances that may cause harm, injury, or illness, when present above an established acceptable level. The four recognized categories of food safety hazards include biological hazards, chemical hazards, physical and allergenic hazards. A food supply should prevent or control food safety hazards along the supply chain. Safe food supplies strengthen national economies, trade, and tourism, contributes to food and nutrition security, and underpin sustainable development. On the contrary, unsafe food endangers everyone and poses global health threats and economic losses. With the increasing demand from local consumers for diversified food products in terms of quality, safety, and other functional properties, the food processing sector plays a vital role in catering to the demand.

Figure 1: Components necessary to regulate for food safety

The food export growth statistics over the last few years clearly

show that the food and beverage processing is moving in a prospective direction in terms of quality and quantity. One of the main challenges faced by the food processing sector is complying with quality and safety requirements demanded by the national regulations and more in terms of exports, meeting requirements of import country specifications. The proliferation and increased stringency of food safety and agricultural health standards harmonized internationally also continue to be challenged in expanding food exports.

In Sri Lanka, a wide array of food safety issues leading to foodborne hazards affect the integrity of food supply chains, and analysis of these phenomena is important in managing food safety along food supply chains. Microbial contamination of food is common along the food supply chain which needs higher attention. Failure to apply food safety strategies and practices at every stage of the food supply chain leads to microbial contamination of foods. Contamination of food with hazardous chemicals has been reported as a major public health concern associated with the food marketed in Sri Lanka. Export food trade is also affected by this aspect; both local and imported food products are reported to contain hazardous chemicals of food safety concern. Related to local food production, uncontrolled activities associated with primary production, food processing, packaging, transportation, and storage are significant contributors to food contamination with chemical food safety hazards. Mislabelling of food products has also been identified as a public health risk associated with food safety. Mislabelling food products includes false advertising, deliberately or leaving out ingredients accidentally, failing to list potential negative health effects, and claiming the presence of non-existent ingredients for financial gain with the intent of deceiving the consumers. As another group of food safety hazards, food allergens continue to be a major concern, especially in the export food trade leading to recalls of food products in many countries. In Sri Lanka there is an increasing number of cases reporting ill - health caused by foodborne allergies, highlighting the need to address preventive measures. Emphasis is now being placed on the ability of all stakeholders to be able to demonstrate adequate traceability of all food sources in the food chain, and improve vigilance with the knowledge to manage food safety with a scientific view.

Food control is defined as a mandatory regulatory activity of enforcement by national or local authorities to provide consumer protection and ensure that all foods are safe during production, handling, storage, processing and distribution, wholesome, and fit for human consumption; conforming to safety and quality requirements and are honestly and accurately labeled as prescribed by law. Food regulations provide mandatory requirements to be followed by stakeholder groups in the food supply chain to control these issues, and the specifications identified not only support local food trade, but also export trade in meeting compliance. Countries need to pay attention to strengthening food regulatory systems, and to take an integrated approach applied along the food chain, "from farm to table", addressing agricultural production systems for both plant and animal-originated foods.

In all countries, food is governed by laws and regulations, which set out the expectations of the State to be met by food chain operators to ensure food safety and quality. The main pillars of food safety control in a country encompass regulations imposed by the competent authorities, effective decision-making by the relevant stakeholder groups, and a set of good practices to manage food safety along the food chain. The term "food law" applies to legislation that regulates the production, processing, manufacturing, packaging, trade, and handling of food, and hence encompasses the regulation of food control, food safety, quality, and relevant aspects of food trade across the entire food chain, from the provision for agricultural raw materials to the consumer.

The national legal framework is the key pillar of an effective food control system. Sri Lanka has enacted a set of laws and regulations that cover the whole food chain. The food control system in Sri Lanka operates through multiple agency systems, where objectives to promote food safety can be sectoral, based on the need for the development of the particular sector. Among stakeholder groups associated with the food chain, a high expectation is placed on governments to undertake the regulatory responsibility to ensure that the food traded within or outside the country's borders is safe for

consumption. The food control administration unit (FCAU) of the Ministry of Health is the administrative body of the national food control system which is committed to ensuring the food reaching the consumers is safe in every respect including locally produced and imported foods under the Food Act No:26 of 1980, which is the primary food law in the country. FCAU is the apex administrative unit responsible to handle all the food safety-related activities, liaison with the food industry, the import-export controls, operations of the field staff, collation of information, and providing administrative support for the Food Advisory Committee (FAC). Acts and regulations governing food quality and safety are developed by the FCAU and some food product standards developed by Sri Lanka Standards Institute are adopted as regulations. Food inspectors (FIs), public health inspectors (PHIs), and food and drug inspectors are the officers empowered by the act to inspect all locally produced and imported food items to verify their compliance with regulations coming under the Food Act No:26 of 1980. They conduct enforcement activities to ensure foods are microbiologically, chemically, and physically safe, hygienically prepared and stored, and honestly presented. If any issue arises in food products traded in the local market, such information is brought to the notice of the Food Advisory Technical Subcommittee for the final decision. Enforcement activities are performed based on testing of foods carried out by approved laboratories mainly for food quality and food safety. Testing for food safety involves quantification of pesticide residues, aflatoxins (mycotoxins), heavy metals, histamines, and microbiological aspects covering pathogenic microorganisms causing risks to human health. To have effective control, food regulations need to be developed with an adequate understanding of food safety hazards that pose risks in the food supply chain. Sri Lanka needs to update the existing food regulations or rather develop new regulations,

Table 1: Agencies responsible for the management of agri-food chain in Sri Lanka

Agri-food sector	Agency
Paddy, pulses, and legumes	Department of Agriculture (DoA) Paddy Marketing Board Institute of Post-Harvest Technology (IPHT)
Fruits and vegetables	DoA IPHT Leading supermarket chains Economic Development Centres Vegetable Growers Association Sri Lanka Food Processors Association (SLFPA) Agribusiness Council
Fish and fishery products	Department of Fisheries and Aquatic Resources (SFAR) National Aquatic Resources &Research Agency (NARA) Ministry of Health (MOH)
Meat and meat products	Department of Animal Production and Health (DAPH) Veterinary Research Institute (VRI) MoH
Coconut and coconut products	Coconut Research Institute (CRI) Coconut Development Authority (CDA)
Tea and tea products	Tea Research Institute (TRI) Sri Lanka Tea Board (SLTB)
Spices and spice products	Department of Export Agriculture (DoEA) Sri Lanka Spice Council Industrial Technology Institute (ITI)

combining information on the occurrence of food safety hazards, epidemiological information, research data of local and global significance, and using principles and concepts of risk-based decision making to ensure food safety meaningfully.

Functions of ensuring food safety nationally are fragmented, and shared by many departments/ divisions or agencies coming under different ministries and institutions. Table 1 depicts the different agencies responsible for the management of the agro-food chain and several parties working in collaboration to ensure quality and safety requirements of agro-based food. The responsible authority for food safety needs to take direct responsibility for food safety management as its main mandate and coordination of food safety management along the whole food chain. Coordination among respective ministries/ departments is a key requirement to enable a coherent and integrated food control management across the food chain. The responsible authority needs to lead the system with a clear vision and collaborate with other ministerial agencies functioning along the food chain, to ensure safety parameters are well managed throughout.

Sri Lanka Standards Institution (SLSI) is the National Standards Body of Sri Lanka. Food standards developed by SLSI are voluntary and cover both product and system standards. Following the authority specified in Imports and Exports (Control) Act No. 47, Sri Lanka Standards Institution (SLSI) food standards and specifications are applied to ensure compliance with 47 imported food items compulsorily, expanding their functions to be involved in import food control. Sri Lanka Standards Institution performs inspections to check the compliance of identified 47 food items among a list of 120 items identified under the imported inspection scheme operated by SLSI. Plant or plant product imports are subjected to a plant import permit that is issued by the Additional Director of National Plant Quarantine Service (NPQS), Katunayake on behalf of the Director-General of Agriculture. It follows regulations under the Plant Protection Act No 35 of 1999. Inspections are carried out by the quarantine officers of NPQS to check compliance. Animal or animal-based products require permits that are obtained from the DAPH veterinary surgeons to undertake inspection activities in deciding the recommendation in releasing the above consignments to the local market.

Food safety assurance adjusts systems to protect the food supply from microbial, chemical, and physical hazards arising during production, harvesting, processing, storage, and transportation and marketing activities. This has necessitated the farm-to-table approach in food safety management applying preventive measures based on risk assessment principles. Nationally competent authorities take initiatives to regularize food safety programs through laws, standards, codes of best practices, and guidelines in accordance with international requirements. Important international standards have been set by the key standard setting bodies namely: CODEX Alimentarius Commission (CAC), Office International des Epizooties (OiE), and the implementation body for the International Plant Protection Convention (IPPC) as well as International Organisation for Standardisation (ISO), to harmonize procedures to address food safety all over the world. International bodies that have played a key part in developing these standards include the World Trade Organisation (WTO), World Health Organisation (WHO), and Food and Agriculture Organisation (FAO). Sri Lanka is a member of these international standard-setting bodies and participates in the development of these standards on food safety, animal health, and plant health. Harmonization of food safety requirements globally emphasizes that all countries need to pay adequate attention to implementing and enforcing food safety management systems based on the modern concept of risk assessment by prioritizing food safety hazards.

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What have you learnt from the Vidurava 2022 April - June Q_2 Issue? Scan your own memory!

1] Safer foods – Better health

True or False?

1. Science and Technology explored new avenues to modify the traditional food, preserve them and make them attractive.
2. Thresholds indicate the limits of inputs or constituents naturally present in soils above which contributions to a food crop may make it unsafe.
3. The system of testing end products have succeeded to ensure food safety in every country.
4. At the level of food processing, Good Manufacturing Practices (GMP) and Good Hygiene Practices (GHP) are not essential to ensure food safety.
5. All food safety management systems in the world are built on the concepts of HACCP.

2] Safe use of additives in the food Industry

True or False?

1. Food processors generate food according to the demands of the population, especially the consumers.
2. A minor function of the food additives is the presentation of the of food.
3. Colorants are used to improve the existing natural color of the processed food ensuring a more attractive product.
4. The sweetness index of some of the sweeteners are much less, preventing achievement of higher sweetness with smaller quantities of additives.
5. The toxicity of permitted food additives is generally low, and the doses to be added are decided through research.

3] Aflatoxins and food safety in Sri Lanka

True or False?

1. There were commercial units established in Pakistan and Tanzania to process animal feeds.
2. The growth of mycotoxin producing molds on food crops is dependent on the moisture content and storage temperatures.
3. Peanuts are grown underground detached to the root system of plants growing on loose soil.
4. Mechanical drying immediately after harvest to reduce the moisture below 12 % is not the best way to avoid mold growth.
5. Controlling humidity and temperatures coupled with forced ventilation to remove moist air from storage spaces help to minimize mold growth.

4] Polycyclic aromatic hydrocarbons in food and safety concerns

True or False?

1. Polycyclic aromatic hydrocarbons (PHAS) are a group of organic compounds containing two or more aromatic rings in their structure.
2. Individual PHAs vary in their ability to cause cancer and toxic effects on the chromosomes of the human gene.
3. In the manufacture of virgin coconut oil, the temperature is kept above 55°C using a water heating jacket around the expeller to prevent the generation of PAHs.
4. Processing and cooking procedures are commonly thought to be the minor source of contamination of PAHs.
5. Good practices and strategies to reduce formation or removal of PAHs are important steps to avoid health risks.

5] Pesticides residues and food safety in Sri Lanka

True or False?

1. While the residues left over in the food at harvest could affect human health, the health of farmers also may be affected due to inhaling pesticide contaminated air.
2. Each pesticide is tested for residual concentrations of the active ingredients present before scientific approval for sale.
3. Food safety problems arise with the spraying of lower doses of pesticides or mixtures of pesticides sold under different trade names.
4. There are no instances where pesticide residues beyond maximum residual limits were detected in food in Sri Lanka.

5. Pesticides can interfere negatively with functioning of the nervous system, respiratory system and the cardio-vascular system of human beings.

6] Packaging foods for safety

True or False?

1. In trade food packaging is primarily expected to help the consumer with the convenience of transport and handling them.
2. Sri Lankan regulations on food packaging material and articles stipulate that a food packaging material should be used.
3. Plastics and packaging materials are damage resistant and not cost effective compared with glass packaging.
4. Suitable packaging materials to provide protection of foods and to be used as marketing tools are selected by food manufacturers.
5. Two common harmful migrants in paper and paper board packaging are dioxane and benzophenone.

7] Food safety in the Sri Lankan hospitality industry

True or False?

1. Food-borne illnesses have decreased over the years positively affecting the health and economic well-being of many developing countries.
2. Food safety is critical in the hospitality industry as prepared foods are more vulnerable to contaminations.
3. The hotels located in high traffic zones face the challenge of maintaining safe and hygienic environmental zones despite their limited space.
4. The importance in the availability of reliable raw materials for the hospitality industry is not a concern of the restaurants.
5. Special attention need to be given to the use of water for food preparation, as water could be a source of contaminants.

8] Veterinary drug residues and food safety in Sri Lanka

True or False?

1. In commercial farming, animal flocks are herded in limited farming areas facilitating spread of diseases among them.
2. Despite many checks and controls, some of the diseases that emerged among human beings were not of animal origin.
3. The use of veterinary drugs or medicines serve two purposes, firstly for prevention or cure of diseases, and secondly to provide nutritional supplements.
4. The decisions on suitability of animal-based products to be released for human consumption is made by veterinarians.
5. With the development of nanotechnology, there will be new veterinary drug delivery systems which may not require new regulatory approaches.

9] Regulating food safety for improved public health

True or False?

1. Food safety quality and hygiene are not only an integral part of food security, but also a public health priority.
2. The proliferation and increased stringency of food safety and agricultural health standards harmonized internationally also continue to be challenged in expanding food exports.
3. Mislabeling of food products has not been identified as a public risk associated with food safety.
4. In all countries, food is governed by laws and regulations, which set out the expectations of the State.
5. Food safety hazards are substances that may cause harm, injury or illness when present below an established level.

Answers

01)1. True, 2. True, 3. False, 4. False, 5. True
02)1. True, 2. False, 3. True, 4. False, 5. True
03)1. True, 2. True, 3. False, 4. False, 5. True
04)1. True, 2. True, 3. False, 4. False, 5. True
05)1. True, 2. True, 3. False, 4. False, 5. True
06)1. True, 2. False, 3. False, 4. True, 5. True
07)1. False, 2. True, 3. True, 4. False, 5. True
08)1. True, 2. False, 3. True, 4. True, 5. False
09)1. True, 2. True, 3. False, 4. True, 5. False

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