

# Food safety – a key to healthy life

## Abstract

Food safety is related to the presence of all those foodborne hazards, which makes food unsafe to consume and injurious to health, if consumed. Food safety is a basic need but there is a danger that it may be overlooked for process efficiency and economy. Food reaches to consumers via supply chains consisting different types of organizations. A critical issue in improving the level of food safety is an integrated approach of controlling the safety of food during the entire food chain i.e. right through farm to the consumer's table, but little is known about the characterization of safe food, the nature of food safety hazards, the establishment of acceptable hazard levels, the strategy of food safety improvement and the methods for valuating the improvement. The increasing incidences of foodborne diseases and its resultant social and economic impact on the human population have brought food safety to the forefront of public health concerns. The considerable increase of illness caused by consuming unhygienic food in both developed and developing countries has provided substantial impact on financial costs besides causing health hazards. This has necessitated the need for the development and introduction of new food safety standards and regulations to reach a higher level of food safety.

**Keywords:** food, safety, hazards, health, illness

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## Introduction

Food safety is considered as an important issue in the field of food processing and hygiene all over the world which have great public health implications. According to the Centers for Disease Control and Prevention estimates that each year roughly 48million people gets sick from a foodborne illness, 128,000 are hospitalized, and 3,000 die.<sup>1</sup> This indicates the severity of food safety issues worldwide. Food Safety refers to all those hazards, which make food injurious to health. These hazards arise from inappropriate agricultural practices, poor sanitation at all stages of the food chain, lack of preventive controls in food processing operations, mishandling of chemicals, contaminated inputs or improper storage and handling. Specific concerns about the food hazards are microbiological and chemical contaminants, veterinary drug residues, pesticide residues, biological toxins and allergens. There are several important aspects, which should be considered to improve food safety. Also there exists the need of professional assistance to consumers regarding food safety issues.<sup>2</sup> Food is reached to consumers by passing through various supply chains of different types of organizations. One defective practice can result in unsafe food leading to health hazards. In a food chain, the food safety hazards can occur at any stage and hence adequate control throughout the supply chain is important. An integrated approach of controlling food safety throughout the entire food production chain ('farm to table') has become essential to attaining a greater level of food safety.<sup>3</sup> The checklist of the points to ensure food safety may go intensive, which is summarized categorically in Table 1.

Looking at the miserable status of food safety in the world, World Health Organization (WHO) stated the theme for World Health Day for the year 2015 as "How safe is your food: From farm to plate, make food safe." The 2015 WHO report on the estimates of the global burden of foodborne diseases presented the first-ever estimates of disease burden caused by 31 foodborne agents (bacteria, viruses, parasites, toxins and chemicals) at global and regional level. India has also not remained untouched by the alarming situation of food safety as the frequent outbreaks of foodborne illnesses occur in all parts of India.<sup>4</sup> Unfortunately, the burden of foodborne diseases to public health and welfare and to economy has often been underestimated

due to underreporting and difficulty to establish causal relationships between food contamination and resulting illness or death.

## What is food safety?

According to Codex Alimentarius Commission,<sup>5</sup> food safety is to guarantee that food will not harm the consumer. Food safety can be defined in a broad or in a more narrow way.<sup>6</sup> In the narrow sense, food safety can be defined as the opposite of food risk, i.e. as the probability of not contracting a disease as a consequence of consuming a certain food. In the broad sense, food safety can be viewed as also encompassing nutritional qualities of food and more wide ranging concerns about the properties of unfamiliar foods, such as many European consumers' uneasiness about genetically modified food.

## Food control system

As the part of control and regulations, there are systems like National Food Control System, which play important role in protecting the consumers from unsafe food and ensure food safety. With elongated food chain, rapidly changing technologies, consumers' negligence, unsafe food habits are challenges faced by the controlling systems. Therefore, it has become necessary to modernize the Food Control Systems. It should be more effective and comprehensive with science-based food law and regulations and an institutional structure, which is active and responds to the needs of food safety management. There should be provision for continuous monitoring, evaluation and amendments. The central, state and local authorities should play complementary and interdependent roles its' implementation. In Indian scenario, all these points will be applicable to the National Food Safety system with the ultimate objective of protecting the consumer.<sup>7</sup>

In particular the Food Control System must:

- i. Make sure that only safe and wholesome foods are marketed
- ii. Take decisions based on scientific procedures
- iii. Empower authorities to detect sources of contamination and take

necessary preventive actions (Figure 1 highlights the sources of food contamination).

- iv. Enforce compliance by farmers, manufacturers, distributors, importers and other stakeholders of the food supply chain
- v. Be transparent and promote public confidence.<sup>7</sup>

Food safety is a combined work of food companies and public. The important economic incentives for companies to provide improved food safety arise from (1) public incentives such as ex ante requirements for sale of a product with sufficient quality and ex post penalties (liability) for sale of products with poor quality, and (2) private incentives for producing quality such as internal performance

goals (self-regulation) and the external (certification) requirements of buyers.<sup>8</sup> In recent years, consumers' confidence in the safety of food has been damaged mainly due to the effect of a number of food-related crises. Many times we experience one or more episodes of foodborne illness, without ever knowing that it was food that caused the illness. Generally, these illnesses are preventable if safe food handling practices are followed. As a consequence, consumers show growing concerns about food safety hazards and hence the demand for safer food increases. The increased demand for safer food has led to the introduction and development of new food safety regulations and standards to reach a goal of higher level of food safety. Moreover, consumers are willing to pay higher prices for safer foods having premium quality.<sup>9,10</sup>

**Table 1** Food Safety–“7” Points “to do”.<sup>3,6</sup>

| Points to do   | Why?   |
|--|--|
| <b>1. Raw Materials Receiving Control</b>  |  |
| <b>i.</b> Purchase raw materials from reliable and reputable sources only  | <b>i.</b> Ensure hygienic quality of food  |
| <b>ii.</b> Reject exposed food which looks, smells or tastes abnormal  | <b>ii.</b> Safe Food Starts with Safe ingredients  |
| <b>iii.</b> Keep a record of receiving   | <b>iii.</b> A good record helps investigation when food incident occurs  |
| <b>iv.</b> Read the label of prepackaged food, adopt first-in-first-out for better rotation  | <b>iv.</b> Ensure the food is not beyond its durability; food is of the type you want; and follow the storage condition and the instruction for use on food labels |
| <b>2. Food Storage</b>   |  |
| <b>i.</b> Always keep  | <b>i.</b> Bacteria in food grow and reproduce fast within dangerous temperature zone from 4oC to 63oC  |
| <b>ii.</b> Raw meat and perishable food below 4oC  |  |
| <b>iii.</b> Cold foods cold (at 4oC or below)  |  |
| <b>iv.</b> Hot foods hot (at 63oC or above)  |  |
| <b>v.</b> Separate cooked food from raw food   | <b>ii.</b> Reduce risk of cross-contamination  |
| <b>vi.</b> Always place food on food shelf 0.5m above floor  | <b>iii.</b> Prevent contamination of food by floor or related activities   |
| <b>vii.</b> Inside the refrigerator:   | <b>iv.</b> Inside the refrigerator   |
| <b>i.</b> Food should be stored in impervious containers wrapped with cling wrap or covered  | <b>i.</b> Prevent cross-contamination of food during storage   |
| <b>ii.</b> Enough space should be kept between trays of food   | <b>ii.</b> Allow cold air to reach every part of refrigerator  |
| <b>iii.</b> Store cooked food in shallow containers  | <b>iii.</b> Allow fast cooling of cooked food  |
| <b>iv.</b> Perishable food should not be stored too long in refrigerator   | <b>iv.</b> Refrigeration only slows down bacterial growth but does not kill bacteria   |
| <b>3. Food Handling and cooking</b>  |  |
| <b>i.</b> Wash all fresh food before cooking   | <b>i.</b> To wash away dirt adhered on food surface  |
| <b>ii.</b> Cut chunky food (meat) into smaller pieces before cooking<br>Thaw frozen Vegetables, meat and poultry thoroughly before cooking | <b>ii.</b> Temperature used during cooking may not be sufficient to kill all micro organisms if all parts are not completely thawed                                |
| <b>iii.</b> Thaw frozen food at 4oC  |  |
| <b>iv.</b> Avoid preparing food too far in advance before consumption  | <b>iii.</b> Keeping at low temperature can lower the rate of multiplication of bacteria  |
| <b>v.</b> Cook food thoroughly. Center of the food to achieve 75oC temperature   | <b>iv.</b> Shorten the time for bacterial growth as far as possible  |
| <b>vi.</b> Reheat foods/leftovers thoroughly as above (only once)  | <b>v.</b> Thorough cooking kills bacteria  |
| <b>vii.</b> While preparing cold mixed dishes, e.g. salad, always cool the cooked component before adding other ingredients                | <b>vi.</b> Thorough heating kills bacteria which develop during storage  |
|  | <b>vii.</b> Large amount of hot food cools down slowly, and during that period, bacteria from other ingredients may multiply                                       |

Table Continued...

| Points to do  | Why?  |
|---|---|
| <b>4. Premises and Equipment Hygiene</b>  |   |
| <b>i.</b> Use separate sets of utensils for handling raw food and cooked food   |   |
| <b>ii.</b> Utensils just used for raw food should not be used to prepare cooked food unless washed and sanitized thoroughly                                 | <b>i.</b> To prevent cross-contamination as utensils for raw food are contaminated with bacteria  |
| <b>iii.</b> Always keep premises clean, in particular kitchen and toilet  | <b>ii.</b> Dirty environment and accumulation of scrap attract rats and vermin and is a potential reservoir of bacteria   |
| <b>iv.</b> Put rubbish and food wastes into impervious waste containers and keep lids of containers closed at all times                                     | <b>iii.</b> Leave no rubbish, food wastes and smell for rats, flies and vermin  |
| <b>v.</b> Protect kitchen and storage area from insects and other vermin. Employ pest control agent if required   | <b>iv.</b> Pests may carry pathogens. Pest control minimizes possible outbreak of food poisoning  |
| <b>vi.</b> Keep refrigerators in good working condition. Clean and defrost them regularly to prevent frost accumulation                                     | <b>v.</b> Assure food is store at 4oC or below and the refrigerator is clean  |
| <b>vii.</b> Wash used utensil with clean water and detergent  |   |
| <b>viii.</b> Sanitize them in boiling water or and approved bactericidal agent  | <b>vi.</b> To reduce bacterial load on utensils   |
| <b>ix.</b> Keep all dangerous chemicals like disinfectants and insecticides in labeled & closed containers away from kitchen area                           | <b>vii.</b> To prevent the possible chemical contamination of food  |
| <b>5. Personal Hygiene</b>  |   |
| <b>i.</b> Wear Clean and light color outfit   | <b>i.</b> Avoid contamination of food with microorganisms and any foreign objects   |
| <b>ii.</b> Use hairnets   | <b>ii.</b> Prevent hair from falling into food  |
| <b>iii.</b> Remove jewellery before working   | <b>iii.</b> Jewellery accumulates muck and may accidentally fall into food  |
| <b>iv.</b> Bandage wounds and septic sores on hands and arms with waterproof dressings  | <b>iv.</b> Wounds and septic sores may be infected with bacteria  |
| <b>v.</b> Wash hands thoroughly with soap and water every time before / after work and after visiting toilet  | <b>v.</b> Hands carry bacteria. Plain water alone cannot remove bacteria and dirt   |
| <b>vi.</b> Turn away from food and cover your nose and mouth when sneezing and coughing. Use a paper towel and wash hands immediately afterwards            | <b>vi.</b> Healthy people may also carry bacteria in their nose and throats   |
| <b>vii.</b> Refrain from Smoking  | <b>vii.</b> Cigarette smoke may bring bacteria in food from smoker's mouth. Cigarette/ butts may fall in food   |
| <b>viii.</b> Do not touch cooked food with bare hands   | <b>viii.</b> Bacteria present on hand passes on food  |
| <b>ix.</b> Report to the Administrator if suffering from sore throat or gastro-intestinal disturbances like diarrhea and vomiting                           | <b>ix.</b> Sick Employees / Teachers may be temporarily assigned jobs other than food handling to prevent food contamination  |
| <b>6. Personnel Training</b>  |   |
| <b>i.</b> Administration should provide job-related and food hygiene training to all staff  |   |
| <b>ii.</b> Both, Administrators and Employees / Teachers should attend food hygiene training seminars/courses run by Government and accredited institutions | <b>i.</b> To enhance their food hygiene knowledge and make them aware of the importance of food hygiene and safety to enable them adopt good food hygiene practices |

## Safe food

There is no generally accepted definition of 'safe food' as such. One of the frequently used science-based definitions is that safe food is "food that is wholesome and that does not exceed an acceptable level of risk associated either with physical or chemical hazards and/or pathogenic microorganisms".<sup>11</sup> The safety of domestic food can be maintained and achieved by implementing simple precautionary measures as given in the following Golden Rules list.

### Golden rules of food safety

- i. Choose processed raw materials.

- ii. Cook food thoroughly.
- iii. Cooked foods should be served as soon as possible.
- iv. Store cooked food at temperatures beyond danger zone.
- v. Reheat cooked food thoroughly.
- vi. Avoid cross contamination.
- vii. Be clean, keep clean and serve clean.
- viii. Ensure pest control.
- ix. Use potable water for cooking.

### Principles of food safety

The food safety principles aim to avoid food contamination and food poisoning. This could be achieved by adopting different avenues, such as:<sup>12</sup>

- i. Proper cleaning and sanitization of all surfaces, utensils and equipments.
- ii. Maintaining a high level of personal hygiene, particularly hand-washing.
- iii. Correct heating, chilling and storing of food with regard to equipment, environment and temperature.
- iv. Implementing effective pest control.
- v. Comprehending food intolerance, food allergies and food poisoning.

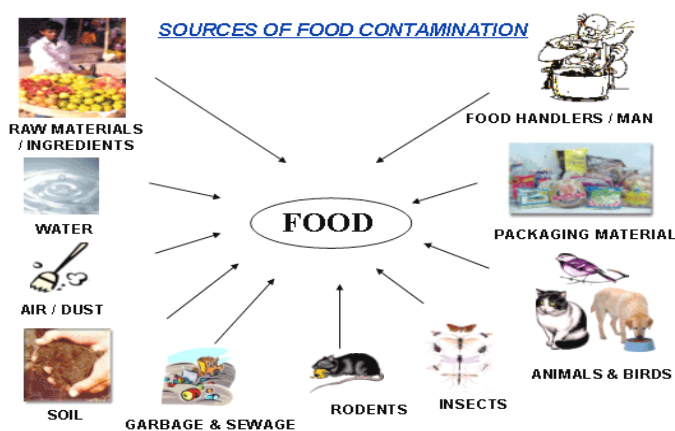


Figure 1 Sources of food contamination.

### Food safety hazards

The definition of ‘safe food’ indicates that a number of hazards may damage food safety and leads to food-borne illnesses. These situations or factors are termed as Hazards. In the widely recognized Hazard Analysis Critical Control Point (HACCP) concept, the term hazard refers to “a physical, chemical and biological agent or the conditions of food with the potential to cause an adverse health effect”.<sup>13</sup> HACCP offers a systematic approach to the identification of hazards and an evaluation of the probability of their occurrence during production, distribution and consumption; it also defines the measures for their control.

Specifically, food safety hazards could be caused by any of the following:<sup>14</sup>

- i. Presence of a physical, chemical or biological contaminant in raw materials, in products that are under process or in even in the finished products.
- ii. Potential for the growth or survival of undesirable microorganisms or the generation of unwanted or unnecessary chemicals in finished products.
- iii. Contamination of semi-finished or finished products with undesirable microorganisms, chemicals or by any unknown material.

In other words, the hazards can be categorized into chemical hazards, microbiological hazards and physical hazards. Among chemical hazards it is important to differentiate between residues such as pesticides, growth promoters and veterinary medicines and contaminants such as dioxins, polychlorinated biphenyls (PCBs) and heavy metals. Figure 2 describes the chemical hazards in food.<sup>7</sup> In contrast to chemical hazards, microbiological hazards are caused by living organisms. Microorganisms can enter the chain at any stage through various origins like animals, workers, environmental contamination, etc. Microbiological hazards refer to microorganisms such as bacteria, viruses, parasites, protozoa and fungi (Figure 3). They can be either toxigenic or infectious. Despite the long list of potential microbiological hazards, a few species and genera (*Clostridium botulium*, *Clostridium peifringens*, *Bacillus cereus*, *Staphylococcus aureus*, *Salmonella*, *Shigella* and *Campilobacter*), and the intestinally pathogenic *Escherichia coli* cause the majority of food-poisoning cases.<sup>7</sup> Physical hazards relate to various foreign particles not normally found in a product. Examples are metal, pieces of wood and sand (Figure 4). The nature of physical hazards in the food chain is rather different from the nature of other hazards. Besides, compared with chemical or microbiological hazards, physical hazards are less likely to affect large numbers of people.<sup>7</sup>



Figure 2 Chemical hazards in food.

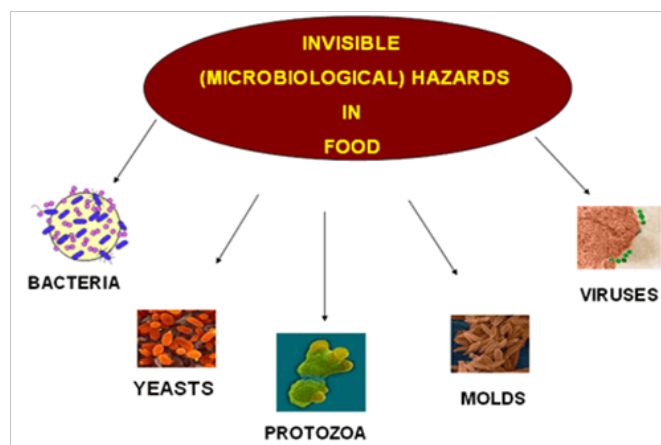


Figure 3 Biological hazards in food.

A considerable difference occurs between microbiological and chemical hazards and hence complete severity cannot be decided for one over another. In contrast to the delicate symptoms of food-borne microbiological illnesses, chemicals usually cause continuous exposure over a lifetime. Chemical substances once present in the

product, do not multiply, but the product cannot be decontaminated.<sup>15</sup> Till date a complete risk assessment has not been made for many of the known hazards. Due to production, processing, distribution and other practices as well as international trade (import and export), new hazards may emerge in addition to the existing hazards.<sup>15,16</sup>



**Figure 4** Physical hazards in food.

### Strategy for improving food safety

The simple strategy for improving food safety revolves around the basic objective i.e. preventing food contamination and when necessary carrying out decontamination. Present production methods cannot totally prevent food contamination and the complexity of food handling and processing methods provide ample opportunity for access as well as survival and growth of pathogens.<sup>17</sup> Government and industry share a common goal to ensure the safety of foods. To achieve this common goal each must fulfill its distinctly separate but complementary roles. Industry has the primary responsibility for ensuring food safety. Government's role is to verify that industry is fulfilling its responsibility.<sup>18</sup> Beyond these basic responsibilities there are many additional activities wherein the two interact. Governments enforce higher safety levels for the nation's food supply in terms of reducing the incidence of food-borne illnesses.<sup>19</sup> At the same time producers along the chain try to meet the existing acceptable hazard levels and to minimize the probability that their products are identified as the cause of an illness.<sup>20</sup> Despite the different backgrounds, all parties are concerned with the way in which a higher level of food safety can be reached in the most economic way. It is important to realize that complete safety is likely to be unrealistic. There can be no 'zero-risk', not only in life generally but even in food. In order to ensure the food safety, a proper food control in compliance with labelling (e.g. in the case of functional food) is required. People have always been concerned about the safety and quality of the food they eat.<sup>21</sup> It is unlikely that in the foreseeable future it will be possible to deliver pathogen-free food. If possible at all, this would mean taking extraordinary measures worldwide and increasing the cost of food beyond levels most people can afford. For this reason, the best strategy is to establish priorities for hazards, foods and consumer groups by means of risk management programmes based on risk-assessment. Risk assessment is necessary for appropriate risk management. In this regard, the role of food chemists and analysts is critical as they have to look that food risk management must be based on sound science and fact.<sup>21</sup> Moreover, applying a number of measures along the chain, including HACCP, can control most potential hazards.<sup>16</sup>

The approaches to food safety criteria that have been developed are based on end product testing which frequently differs among various

nations.<sup>22</sup> Because of the non-uniform distribution of microorganisms in the end product and possible recontamination during the production process these approaches do not guarantee total absence of pathogens. Simultaneously, microbiological inspection of all food is physically and financially impossible.<sup>16</sup> In addition, it is impractical to apply end-product microbiological criteria for products that will have been distributed and probably consumed before microbiological examinations are completed.<sup>23</sup> So, appropriate measures need to be implemented at the earlier stages in the food chain in order to prevent the presence of a hazard in later stages. Making food safe from the hazards involves prevention, elimination or reduction of the hazards by means of a set of diverse actions and activities, i.e., a set of control measures.<sup>13</sup> It is hard, probably impossible, to eliminate all potential microbiological hazards from the environment. Besides, if microorganisms are present in a product, they may multiply themselves. As a result, control of microbiological hazards in a single stage does not ensure their absence in subsequent stages in the chain. This makes the control of microbiological hazards complicated as a set of measures implemented in one stage has consequences for the subsequent stages in the chain.<sup>24</sup> Contamination and spread could probably be controlled by educating the masses regarding food safety. Food safety education is the most effective means of spreading messages regarding foodborne illness likely to be caused due to changing behaviors. The five major control factors for pathogens are adequate cooking, keeping food at safe temperatures, avoiding foods from unsafe sources, avoiding cross-contamination and personal hygiene.<sup>25</sup> The lower the pathogen 'load' of primary products (inputs), the smaller the chance that pathogens reach the consumer and lead to food-borne illness.<sup>16</sup>

Contaminated food causes considerable health and economic consequences for individuals, families, population groups and entire countries. Epidemiological surveillance in several industrial countries during the last two to three decades indicates that there is even a considerable increase in the prevalence of foodborne illness. In developing countries, infant diarrhoea appears to be the most important health problem related to contaminated food.<sup>26</sup> While few patients with foodborne illness present with life-threatening symptoms, there are a number of foodborne infectious diseases and toxins that the emergency physician or other health care provider must consider in the evaluation of these patients.<sup>27</sup> One of the most important strategies to reverse the upward trend of foodborne diseases is, therefore, for the health sector to get fully involved in food safety. Mandatory and voluntary adoption of Hazard Analysis Critical Control Points in the foodservice and processing industries will contribute to a decrease in foodborne illness outbreaks from traditional foods.<sup>28</sup> Food can't any longer be considered only as an agricultural/trade commodity but must be seen as a public health issue and Ministries of Health have to accept food safety as an essential public health function, as recently recommended by the World Health Organization.<sup>26</sup>

### WHO's response on food safety

WHO aims to facilitate global prevention, detection and response to public health threats associated with unsafe food. Ensuring consumer trust in their authorities, and confidence in the safe food supply, is an outcome that WHO works to achieve. In order to do this, WHO helps Member States to build capacity to prevent, detect and manage foodborne risks by:

- i. Providing independent scientific assessments on microbiological and chemical hazards that form the basis for international food

- standards, guidelines and recommendations, known as the Codex Alimentarius, to ensure food is safe wherever it originates;
- ii. Assessing the safety of new technologies used in food production, such as genetic modification and nanotechnology;
- iii. Helping improve national food systems and legal frameworks, and implement adequate infrastructure to manage food safety risks. The International Food Safety Authorities Network (INFOSAN) was developed by WHO and the UN Food and Agriculture Organization (FAO) to rapidly share information during food safety emergencies;
- iv. Promoting safe food handling through systematic disease prevention and awareness programmes, through the WHO Five Keys to Safer Food message and training materials; and
- v. Advocating for food safety as an important component of health security and for integrating food safety into national policies and programmes in line with the International Health Regulations (IHR - 2005).

WHO works closely with FAO, the World Organization for Animal Health (OIE) and other international organizations to ensure food safety along the entire food chain from production to consumption.<sup>29</sup>

### Role of Food Safety Management System (FSMS) in implementing food safety

Food quality and safety has received attention in the food processing sector and is the basis of all initiatives taken on different activity levels starting from farm to enterprises as a whole on regional, national and international levels. In order to prevent food from getting contaminated at any point- “from farm to fork, from stable to table, from boat to throat, from spring to drink and from plough to plate”, the ISO 22000 standard was published by International Organization for Standardization (ISO) which is engaged in the quality management systems and is focused on safety and quality of food. ISO 22000 also known as Food Safety Management System (FSMS) is an international auditable standard which has been developed as an international solution for improving the food safety. It is a fusion of the ISO 9001, Quality Management System and Hazard Analysis and Critical Control Point (HACCP). ISO 22000:2005 is implemented to ensure food safety in the food supply chain as a replacement for of applying ISO 9001:2000, HACCP and good manufacturing practices independently. It ensures supply of safe food throughout the food chain and provides a framework of internationally harmonized system that has universal acceptance. Consecutively, ISO 22000 produces a much effective auditable FSMS approach by incorporating critical control point and hazard analysis systems in more improved structure. This standard endorses conformity of services and products for international trading by assuring about reliability, food quality and food safety. ISO 22000 along with its sister standards are auditable, reliable, and reasonable to ensure safe production, distribution, and consumption of food.<sup>30</sup>

### Future challenges

- i. Management of food safety is based on generally accepted principles of Hazard Analysis Critical Control Points and of Good Manufacturing Practices. However, a more pro-active, science-based approach is required, starting with the ability to predict where problems might arise by applying the risk analysis framework.<sup>31</sup>

- ii. Though food safety is assured by FSMS throughout food chain, it is utmost necessary to maintain the global prevalence of ISO 22000 series as well as to frequently amend the already published standards. Also new standards need to be developed along with the technical specifications as per the need of product, services and market.<sup>30</sup>
- iii. Despite numerous food safety information campaigns and educational efforts, microbial foodborne illness remains a significant source of human disease.<sup>32</sup> Microbes that enter the food chain at different steps are highly versatile and can adapt to the environment allowing survival, growth and production of toxic compounds. This sets them apart from chemical agents and thus their study from food toxicology.<sup>31</sup> New food safety messages transmitted using new media are required to enhance food safety from farm-to-fork.<sup>32</sup>
- iv. Developments that may influence food safety in the future occur on different scales (from global to molecular) and in different time frames (from decades to less than a minute). Taking into account the impact of different drivers of change, new risk assessment approaches should be developed.<sup>31</sup>
- v. Considering the risk associated with recurrent outbreaks of foodborne illness from commercial food sources, it is important to recognize various syndromes of foodborne illness, including those, which may require specific evaluation and management strategies.<sup>27</sup>
- vi. Current developments in molecular techniques make it possible to rapidly assemble information on the genome of various isolates of microbial species of concern. Such information can be used to develop new tracking and tracing methods, and to investigate the behavior of microorganisms under environmentally relevant stress conditions.<sup>31</sup>
- vii. Food safety education and evaluation in the future should be organized around five behavioral constructs: cook foods adequately, keep food at safe temperatures, avoid food from unsafe sources, avoid cross-contamination and practice personal hygiene.<sup>33</sup>
- viii. Food processing sectors are adopting new technologies like pulse electric field, electrolyzed oxidation, ultra sonication, ohmic heating, etc., so as to maintain better sensory and nutritional qualities of food. Hence, there is need to amend, upgrade, revise and promote the criteria for food safety.<sup>34,35</sup>

### Conclusion

Food safety itself is rather complex. There is no single indicator that can be used to measure the safety of food products. Food safety is a joint responsibility of all organizations with in the food chain including, producers, manufactures, transport and storage operators, sub contractors, retail and food service outlets and service providers. In addition, the increasing complexity of the global food systems necessitates improved communication between all parties involved: scientists, risk assessors and risk managers, as well as consumers.

Food safety failures often arise from problems caused by the ability of hazards to enter the production chain at many points. For food safety hazards, the established acceptable levels are implicit and need further clarification to make the process of food safety improvement understandable for producers. With an aging population

and an increased number of people at risk due to medical conditions for foodborne illness, food and nutrition professionals should be involved in collaborative food safety issues in educational, research and policy agenda settings. More research is needed to understand the strengths, weaknesses, and relative impact of each country's legal system on the incentives to produce safer food.

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None.

## Conflicts of interest

The authors declare that there is no conflict of interest.

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