Unit – 5 Food spoilage and Quality assurance

Food borne diseases caused by microorganisms are subdivided into 2 types—

A) **Food poisonings**
B) **Food infections**

A) Food poisonings: -

Food poisonings can be the result of either chemical poisoning or the ingestion of a toxicant (intoxication). The toxicant might be found naturally in certain plants or animals or be a toxic metabolic product excreted by microorganisms. Bacterial food intoxication therefore refers to food borne illness caused by the presence of a bacterial toxin formed in the food.

There are two main kinds of food intoxications / poisonings caused by bacteria—

1. **Botulism caused by toxin in food by *Clostridium botulinum***
2. **Staphylococcal intoxication by *Staphylococcus aureus***

1. Botulism: -

Botulism is a disease caused by the ingestion of food containing the neurotoxin produced by *Clostridium botulinum.*

The organism: -
This rod shaped soil bacterium is saprophytic, spore forming, gas forming, and anaerobic. Seven types are distinguished on the basis of the serological specificity of their toxins. The predominant toxin from these types is designated by the same capital letter.

Type A: - It is the one commonly causing human botulism in the western part of the United States. It is more toxic than type B.

Type B: - It is found more often than type A in most soils of the world and is less toxic to human beings.

Type C: - It causes botulism of fowls, cattle, and other animals but not of human beings.

Type D: - It is associated with forage poisoning of cattle in the Union of South Africa.

Type E: - It is toxic for humans, and is obtained from fish and fish products.

Type F: - It is similar to types A and B, has been isolated in Denmark and produces human botulism.
Type G: - It is isolated from the soil in Argentina but has not been implicated in human botulism.

Not all types produce a single toxin, but produce mixture of toxins. The *Cl. Botulinum* ferments carbohydrates with gas production. The strains are divided into 3 general groups, based on cultural and physiological characters.

Group I: - It includes all type A strains (proteolytic) and the proteolytic strains of B and F.

Group II: - It includes all type E strains (non-proteolytic) and the non-proteolytic strains of B and F.

Group III: - It includes type C and D, they are non-proteolytic and share a common metabolic pattern.

- **Growth and Toxin production: -**

Toxin production by *C. botulinum* depends on the ability of the cells to grow in a food and to autolyze there, therefore, factors that influence spore germination, growth, and hence toxin production are of special interest. These factors include the composition of the food, moisture content, pH, O-R potential, salt content, temperature and time of storage of the food.

Meats, fish, and low or medium acid canned foods have been shown to support toxin production. The media containing milk or casein, glucose or maltose, and corn steep liquor yield more potent type A toxin than other media. More NaCl is needed at higher temperature, such as 37 C, than at a lower one, at 15 C. A PH near neutrality favours the growth. A pH 4.5 or lower prevents toxin production. The optimum temperature for toxin production and the growth of the proteolytic strains is about 35 C. Low O-R potential (anaerobic condition) is required for the growth and toxin production.

- **The toxin: -**

The toxin of *C. botulinum* is protein in nature and is powerful in minute amount to cause death. It is absorbed in the small intestine and paralyses the involuntary muscles of the body. It is thermo labile i.e. can be destroyed by heat. In the laboratory, heat treatments of 5 to 6 minutes at 80 C will inactivate type A toxin, while 15 min at 90 C will inactivate type B toxin. The toxin can be destroyed in cheese by 7.3 Mrad of gamma rays and in broth by 4.9 Mrad. The toxin has been known to persist in foods for long periods, especially when storage has been at low temperature. It is unstable at pH values above 6.8.

The seven toxins (A to G) are antigenic, causing the production of antitoxin specific for a given toxin type injected. Toxoids have been prepared for the active immunization.

Toxicity and Bacteriophages: -

Recent studies on the relationship between toxigenecity and bacteriophages have suggested that the bacterial genome may not be responsible for the production of the toxin but is coded for by the genome of an incorporated temperate bacteriophage. This would explain the occasional loss of toxigenecity by some strains.

Heat resistance of spores: -

The resistance of spores of *C. botulinum* is more than that of spores of other species of clostridium. The heat treatment necessary to destroy all the spores in the food depends on the kind of food, type of strain, medium, temperature, number of spores and the age of the spores. In general, spores of type C, D, and E are less heat resistant than type A and B. Type E spores are inactivated in 15 min at 80 C.

Distribution of spores: -

Spores are found in both cultivated and virgin soils all over the world. Type A spores are found more in western soils in this country and type B spores elsewhere. Type E spores are found in sea, lake mud, and in fish.

Incidence of Botulism: -

Fortunately, botulism occurs only rarely, but it always receives much attention because of the high mortality. The fatality rate in between 1970 to 1973 was 23 %, but in between 1899 to 1949 it was above 60 % in United States.

Foods involved: -

In the United States, inadequately processed home-canned foods are most often the cause of botulism. In Europe causes are preserved meats and fish. Of the home canned foods, those most often responsible for botulism have been string beans, sweet corn, beets, asparagus, and spinach. The spores of *Cl. Botulinum* survive long storage periods in raw and precooked frozen foods and can grow and produce toxin.

The disease: -

People are so susceptible to botulism that if low amounts of toxin are present, everyone who eats the food becomes ill and consumption of very small pieces of food can cause illness and death.

Symptoms: -

→ The typical symptoms usually appear within 12 to 36 hours, although longer or shorter time may be required.

→ The earliest symptoms usually are acute digestive disturbances followed by nausea and vomiting and possibly diarrhoea.

→ Fatigue, dizziness and headache.

→ Constipation, double vision, difficulty in swallowing and speaking.

→ Dryness of the mouth and constriction of the throat, swollen and coated tongue.

→ Temperature normal, involuntary muscles become paralysed, paralysis spreads to the respiratory system and heart

→ Death results from respiratory failure.

Treatment: -

The only known method for the successful treatment of botulism is the administration of antitoxin. Unfortunately, this injection usually is not successful if made after the symptoms have appeared, but it should always be used at the earliest possible moment. Other treatments include artificial respiration, keeping the patient quiet, maintaining the fluid balance in the body, removal of food from the digestive system.

Prevention: -

The methods for the prevention include—

→ Use of approved heat processes for canned foods

→ Rejection of all gassy (swollen) or spoiled canned foods

→ Refusal even to taste a doubtful food

→ Avoidance of foods that have been cooked, held, and not well reheated

→ Boiling of suspected food for at least 15 minutes.

2. Staphylococcal intoxication

One of the most commonly occurring food poisonings is caused by the ingestion of the enterotoxin formed in food during growth of certain strains of *Staphylococcus aureus.*

The organism: -

The organism is a typical staphylococcus, occurring in masses like clusters of grapes or in pairs and short chains. Growth on solid media usually is golden or yellow but may be unpigmented in some strains. Most enterotoxin producing *S. aureus* cultures are coagulase positive, facultative anaerobic, salt tolerant (10 to 20 % NaCl), nitrite tolerant, sugar tolerant, fermentative and proteolytic, produce 6 serologically distinct enterotoxins (A, B, C_1, C_2, D and E), most food poisoning is from type A.

The range of conditions permitting growth of the staphylococci, and hence toxin production, varies with the food involved. In general, the better medium the food is for the cocci, the wider the range of temperature, pH, or a_w over which growth can take place.

The temperature range for growth and toxin production is about 4 to 46 C, depending on the food. The million staphylococci per ml or gram of perishable foods will be inactivated by 66 C maintained for at least 12 min or by 60 C at 78 to 83 min.

The sources from which the food poisoning staphylococci enter foods are for the most part human or animal. The nasal passages of many persons are a common cause of infection. Staphylococci are becoming increasingly important in causing mastitis in cows. Ordinarily, air is a relatively important source of the cocci.

The enterotoxin: -

The staphylococcal enterotoxins are simple proteins with molecular weights between 26,000 to 30, 000. The single polypeptide chains are cross-linked by a disulfide bridge to form a characteristic **cystine loop.** Six types of serologically distinct enterotoxins (A, B, C_1, C_2, D and E) are produced by staphylococci. A and D types are more often associated with food poisoning outbreaks. Appreciable levels of enterotoxin are produced only after considerable growth of the staphylococci.

This enterotoxin is stable to heat. The normal cooking of foods will not destroy the toxin; such foods might cause poisoning, although no live staphylococci could be demonstrated.

Incidence of the disease: -

There are no reliable figures on the numbers of cases in the United States or any of the states for any given period. The poisoning usually is not reported or publicised unless the outbreak is fairly large.

Foods involved: -

Custard and cream filled bakery goods, ham, and poultry have caused the most outbreaks. About 75 % of all staphylococcal food poisoning outbreaks occur because of inadequate cooling of foods. Other foods include meat and meat products, fish and fish products, milk and milk products, cream sauces, salads, puddings, custards, and salad dressings. Growth and toxin production may take place in the steam tables in cafeterias and restaurants and in food vending machines that keep foods heated for extended periods if temperatures and times are not properly controlled.

The disease: -

Individuals differ in their susceptibility to staphylococcal poisoning, some may become very ill and few may be affected little or not at all. The incubation period is brief, 2 or 4 hours.

Symptoms: -

→ Salivation, then nausea, vomiting, abdominal cramping, diarrhoea.

→ Blood and mucous may be found in stools in severe cases.

→ Headache, muscular cramping, sweating, chills, weak pulse, shock, and shallow respiration may occur.

→ Subnormal body temperature rather than fever.

→ The duration is brief, usually 1 or 2 day, and recovery ordinarily.

→ The mortality is extremely low.

Conditions necessary for an outbreak: -

→ The food must contain enterotoxin-producing staphylococci

→ The food must be a good culture medium for growth and toxin

→ The temperature must be favourable for the growth of staphylococci, and enough time must be allowed for production of enterotoxin

--> The enterotoxin-bearing food must be ingested.

Prevention: -

1. Prevention of the contamination of the food with the staphylococci
2. Prevention of the growth of the staphylococci
3. Killing staphylococci in the foods.

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B) Food infections

A bacterial food infection refers to food-borne illness caused by the entrance of bacteria into the body through the ingestion of contaminated foods and the reaction of the body to their presence or to their metabolites.

Examples are—

1. Salmonellosis
2. Clostridium perfringens gastroenteritis
3. Bacillus cereus gastroenteritis
4. Escherichia coli illness
5. Shigellosis
6. Cholera

Sr. No.	**Disease & Causative organism**	**Morphology**	**Incubation period, symptoms**
1	**Salmone llosis** Salmonella enteritidis, typhimurium, derby, java, infantis,	Gram negative, non-spore forming rods, ferment glucose with gas, do not ferment lactose or sucrose	5-72 hrs, diarrhoea, abdominal pains, chills, fever, vomiting, dehydration, anorexia, headache, malaise.
	Typhoid fever Salmonella typhi	-- Do --	7-28 days, Septicemia and lymphoid tissue involved, malaise, headache, high continued fever, cpogh, nausea, vomiting, constipation, slow pulse rate enlarged spleen, chills.
	Paratyphoid fever Salmonella paratyphi A,	-- Do --	1-15 days, bloodstream infection, headache,

	paratyphi B, paratyphi C		continued fever, profuse perspiration, nausea, vomiting, abdominal pain, enlarged spleen, diarrhoea
2	**Clostridium perfringens Gastroenteritis** Clostridium perfringens (welchii)	Gram positive, rods, nonmotile, anaerobic, spore forming	8-24 hrs, Acute abdominal pains, diarrhoea, gas, fever.
3	**Bacillus cereus gastroenteritis** Bacillus cereus	Gram positive, rods, spore forming, aerobic,	8-16 hrs, nausea, abdominal cramps, watery diarrhoea, vomiting.
4	**Escherichia coli infection** Enteropathogenic Escherichia coli (EEC)	Gram negative, motile, lactose fermenting, enterotoxin producing	8-24 hrs, fever, chills, headache, abdominal cramps, watery diarrhoea,(rice-water stools), vomiting, dehydration, shock, similar to cholera.
Sr. No.	**Disease & Causative organism**	**Morphology**	**Incubation period, symptoms**
5	**Shigellosis** Shigella sonnei, flexneri, dysentrae, boydii	Gram negative, rods, nonmotile, non-spore forming	1-7 days, abdominal cramps, fever, chills, watery stools containing blood, mucous or pus, headache, prostration, nausea, dehydration.
6	**Cholera** Vibrio cholerae, parahaemolyticus	Gram negative, comma shaped. Motile, non-spore forming	2-48 hrs, abdominal pains, fever, chills, watery stools containing blood, mucous or pus, headache, prostration, nausea, dehydration. More vomiting, fishy odour to stool & vomit.

*** Foods involved and control measures of food infection**

Sr. No.	**Disease**	**Foods involved**	**Control measures**
1	**Salmonellosis**	Moist, mixed foods, milk, beans, potato, fruits,	Cook foods thoroughly, chill foods rapidly in small quantities, prevent cross contamination, protect foods from contamination.
2	**Clostridium perfringens Gastroenteritis**	Meat and meat products, Fish and fish products,	-- Do --

3	**Bacillus cereus gastroenteritis**	Custards, cereal products, puddings, sauce.	-- Do --
4	**Escherichia coli infection**	Milk & milk products, Beverages.	Proper pasteurization and heating
5	**Shigellosis**	Moist, mixed foods, milk, beans, potato, fruits,	Cook foods thoroughly, chill foods rapidly in small quantities, prevent cross contamination, protect foods from contamination.
6	**Cholera**	Raw foods of marine origin, fish and fish products.	-- Do --

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Mycotoxins

Some food borne diseases are caused by the consumption of the foods containing **mycotoxins**, which are produced by fungi. Some are highly toxic to animals and human beings.

1. Aflatoxin
2. Patulin
3. Ochratoxin
4. Luteoskyrin
5. Sterigmatocystin
6. Penicillic acid
7. Alimentary toxic Aleukia (ATA)
8. Roquefortine

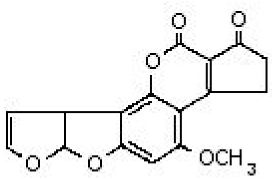
Sr. No.	**Name of Mycotoxin**	**Producing Fungus**	**Foods or feeds isolated from**
1	Aflatoxin	*Aspergillu Flavus, A. parasiticus, some penicillium*	Barley, corn, cottonseed, oats, peanuts, rice, soyabean, wheat, sorghum, peas, sweet potatoes, soyabean meal.
2	Patulin	*Penicillium expansum, P. claviforme, P. patulum, P.*	Apple sap, apple cider, apple juice

		melinii, P. cyclopium, Aspergillus clavatus, A. terreus	
3	Ochratoxin A	*Aspergillus ostianus, A. ochraceus, A. petrakii, A. alliaceus, A. sulphurous, Penicillium cyclopium, P. commune.*	Corn, wheat, barley, white beans, peanuts, bread, eggs
4	Luteoskyrin	*Penicillium islandicum*	Rice flour
5	Sterigmatocystin	*Aspergillus regulosus, A. nidulans, A. versicolor, Penicillium luteum*	Wheat, oats
6	Penicillic acid	*Penicillium puberulum, P. cyclopium, P. thomii, P. madriti, A. sulphurous, A. mellens*	Dried beans, tobacco
7	Alimentary toxic aleukia (ATA)	*Species of Cladosporium, Penicillium, Fusarium, Mucor, Alternaria*	Grain
8	Roquefortine	*Penicillium roqueforti*	Cheese,

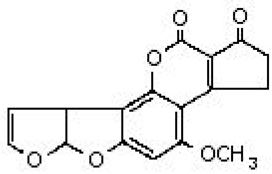
Sr. No.	**Name of mycotoxin**	**Toxic to**	**Carcinogenic to**
1	Aflatoxin	B_1 quail, cats, chickens, rabbits, monkeys, dogs, hamsters, cattle, guinea pigs	B_1 trout, rats, sheep, mice, ducklings
2	Patulin	Mice, rats, cats, rabitts, quail,	Mice,
3	Ochratoxin A	Rats, chicks, ducklings	Rats, trout, chicks
4	Luteoskyrin	Mice	Mice
5	Sterigmatocystin	Mice, monkeys, rats	Rats
6	Penicillic acid	Rats	Rats
7	Alimentary toxic aleukia (ATA)	Human beings	--
8	Roquefortine	Mice	--

1. Aflatoxins: -

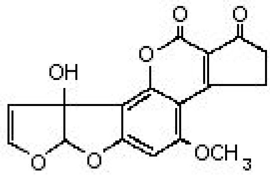
Oxygenated heterocyclic compounds, 2 main aflatoxins B_1 and G_1 because they fluoresce blue & green under U.V. B_2 and G_2 are dihydroderivatives of B_1 and G_1. M_1, M_2 & P_1 are hydroxylated derivatives of B_1 and G_1.



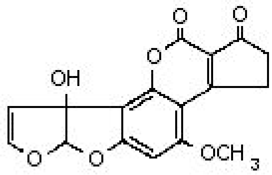
AFLATOXIN B_1



AFLATOXIN B_2



AFLATOXIN M_1



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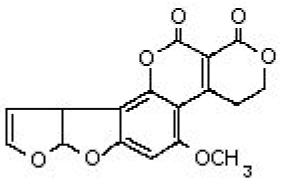
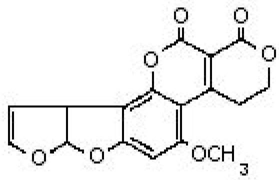


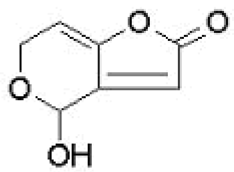
AFLATOXIN G_1



AFLATOXIN G_2

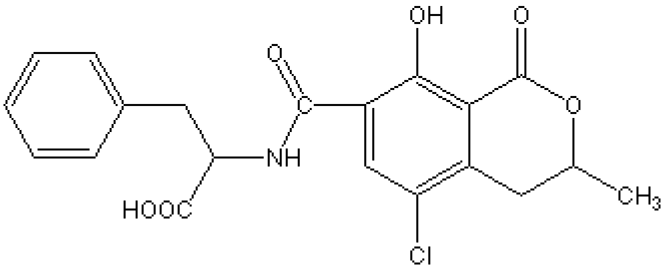
2. Patulin: -

Unsaturated lactone, 4-hydroxy-4H-furo[3, 2c]pyran-2(6H)-one. White crystal, melting point 110.5C, M.w. 154, sensitive to SO_2 , unstable in alkali but stable in acid.

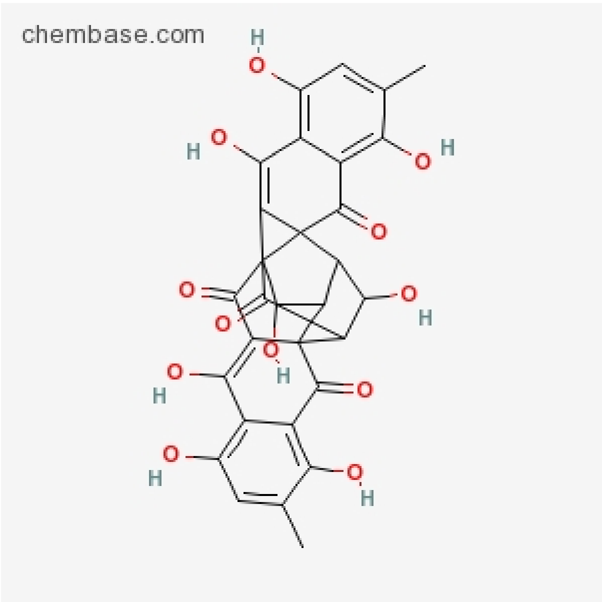


3. Ochratoxin: -

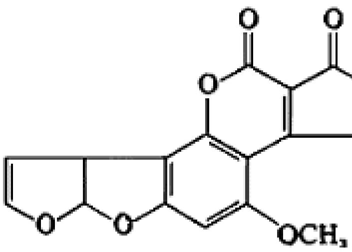
Chlorinated isocoumarin derivative with an amide bond to phenylalanine. It fluoresces green under U.V.



4. Luteoskyrin



5. Sterigmatocystin



Quality assurance in Food

Consumers worldwide always demand to have their foods of higher standards or better quality. However, the term standard or quality is more often than not unclear. In many cases quality means different things to different people. Food quality may be its sensory property (appearance, taste), nutritional value (nutrient content), health benefit (functional ingredient) or safety (chemical, physical, biological). There is general consensus that food safety is the very basic right of people and various efforts have been devoted by all sectors to ensure that the goal of safer food for all would be attained.

Keeping pace with the global economic development, there has been a dramatic increase in both the quantity and variety of food moving in international trade. In this aspect, the standards, guidelines or recommendations of the Codex Alimentarius Commission (CAC) should be honored. The CAC was established in 1962 by the United Nations Food and Agriculture Organization (FAO) in collaboration with the World Health Organization (WHO) to implement the Joint FAO/WHO Food Standards Programme. The primary objective of the Programme is, and will continue to be, protecting the health of the consumer and ensuring fair practices in the food trade by the elaboration of internationally acceptable standards for food.

Generally the basic components of a Codex commodity standard include:
(1) description; (2) essential composition and quality factors; (3) contaminants; (4) food additives; (5) hygiene; (6) weights and measures; (7) marking or labeling; and (8) methods of analysis and sampling.

Food product quality is a prime criterion in gaining access to competitive markets. Most marketers will agree that besides everything else commercial markets require a stable supply and consistent quality. Most industries especially small and medium ones do not like to be pioneers and it takes considerable efforts to interest markets unless the quality assurance criteria is assured with confidence in the form of a policy. Food products which cannot reach equivalent levels of quality, functionality or reliability will not survive in the competitive global markets. There is only so much that a more equitable environment can offer. The rest depend upon the food quality polices of the enterprises and the nations.

Food Standards Agency

The FSA promotes the microbiological safety of food throughout the food chain. It is responsible for the strategy for reducing foodborne illness, promoting a hazard analysis-based approach to food safety management and providing guidance for producers, retailers, caterers and the general public. It also deals with microbiological food hazards and outbreaks of foodborne disease.

A legal food processing plant should fully comply to the plant standards and other relevant rules governed and regulated by the law governing food sanitation and administered by the Department of Health, Currently, most of the food enterprises have the ability to enforce Quality Inspection (QI) which implied that they possess basic analytical instruments and skills (such as chemical analysis and microbiological analysis).

Microbiological quality standards of food

The major microbiological components listed in the Guidelines

a) Aerobic Colony Count (ACC)

"Aerobic colony count (ACC)" is a count of viable bacteria based on counting of colonies grown in nutrient agar plate at **30°C for 48 hours**. ACC is useful for indicating the sanitary quality of food. Generally, it does not relate to food safety hazards, but is taken as a food quality parameter.

b) Indicator organism - Escherichia coli (total) count

"Indicator organisms" refer to the selected surrogate markers employed to reflect the hygienic quality of food. *E*. coli is commonly used as surrogate indicator. The native habitat for *E*. coli is the enteric tract of human and animals. Its presence in food generally indicates direct or indirect faecal contamination. Substantial number of *E*. coli in food suggests a general lack of cleanliness in handling and improper storage. The presence of *E*. coli in foods does not connote directly the presence of a pathogen, but implies a certain risk that it may be present.

c) Specific pathogens

"Specific pathogens" refer to bacteria that may cause food poisoning. Mechanisms involved may be toxins produced in food or intestinal infection. Symptoms of food poisoning vary from nausea and vomiting (e.g. caused by S. aureus), through diarrhoea and dehydration (*Salmonella* spp. and Campylobacter spp.) to paralysis and death in the rare cases of botulism. The infectious doses vary from less than 10 to more than 10^6 organisms.

The following guidelines are used to assess the microbiological safety of foods and should be read in conjunction with the 'Special Notes'.

Test Type	*Satisfactory*	*Fairly Satisfactory*	*Unsatisfactory*	*Unacceptable*
	Unlikely to cause disease.	*Unlikely to cause disease. Indicate possible hygiene problems with food handling preparation.*	*May cause disease in some people. Food not manufactured hygienically.*	*Likely to cause disease in most people.*
	Action: Nil.	*Action: If these results are produced regularly, examine hygiene and handling practices.*	*Action: Investigate production practices.*	*Action: Withdraw any food still on sale. Follow up any known contacts. Investigate production practices.*
Bacillus cereus	Less than 100/g	Between 100 and 1000/g	Between 1000 and 10 000/g	More than 10 000/g
Campylobacter spp.	Not detected in 25g	—	—	Present in 25g
Clostridium perfringens	Less than 100/g	Between 100 and 1000/g	Between 1000 and 10 000/g	More than 10 000/g
Escherichia coli (E. coli)	Less than 10/g	Between 10 and 70/g	More than 70/g	Contains verotoxigenic *E. coli*
Listeria monocytogenes (At point of manufacture)	Not detected in 25g	—	Less than 10/g	More than 10/g
Listeria monocytogenes (At retail)	Not detected in 25g	Less than 10/g	Between 10 and 100/g	More than 100/g
Salmonella spp.	Not detected in 25g	—	—	Present in 25g
Coagulase positive Staphylococcs	Less than 100/g	Between 100 and 1000/g	Between 1000 and 10 000/g	More than 10 000/g
Vibrio parahaemolyticus *	Not detected in 25g	—	Less than 1000 in 25g	More than 1000 in 25g

Government regulatory practices and policies

1. Hazard analysis and critical control points (HACCP)
2. FDA (Food and Drug Administration)
3. EPA (Environmental Protection Agency)
4. ISI (Indian Standards Institution)

1. Hazard analysis and critical control points (HACCP)

Hazard analysis and critical control points or **HACCP** is a systematic preventive approach to food safety and pharmaceutical safety that addresses physical, chemical, and biological hazards as a means of prevention rather than finished product inspection. HACCP is used in the food industry to identify potential food safety hazards, so that key actions can be taken to reduce or eliminate the risk of the hazards being realized. The system is used at all stages of food production and preparation processes including packaging, distribution, etc. The Food and Drug Administration (FDA) and the United States Department of Agriculture (USDA) say that their mandatory HACCP programs.

The HACCP seven principles

Principle 1: Conduct a hazard analysis. – Plans determine the food safety hazards and identify the preventive measures the plan can apply to control these hazards. A food safety hazard is any biological, chemical, or physical property that may cause a food to be unsafe for human consumption.

Principle 2: Identify critical control points. – A critical control point (CCP) is a point, step, or procedure in a food manufacturing process at which control can be applied and, as a result, a food safety hazard can be prevented, eliminated, or reduced to an acceptable level.

Principle 3: Establish critical limits for each critical control point. – A critical limit is the maximum or minimum value to which a physical, biological, or chemical hazard must be controlled at a critical control point to prevent, eliminate, or reduce to an acceptable level.

Principle 4: Establish critical control point monitoring requirements. – Monitoring activities are necessary to ensure that the process is under control at each critical control point. In the United States, the FSIS is requiring that each monitoring procedure and its frequency be listed in the HACCP plan.

Principle 5: Establish corrective actions. – These are actions to be taken when monitoring indicates a deviation from an established critical limit. The final rule requires a plant's HACCP plan to identify the corrective actions to be taken if a critical limit is not met. Corrective actions are intended to ensure that no product injurious to health or otherwise adulterated as a result of the deviation enters commerce.

Principle 6: Establish procedures for ensuring the HACCP system is working as intended. – Validation ensures that the plants do what they were designed to do; that is, they are successful in ensuring the production of a safe product. Plants will be required to validate their own HACCP plans. FSIS will not approve HACCP plans in advance, but will review them for conformance with the final rule.

Verification ensures the HACCP plan is adequate, that is, working as intended. Verification procedures may include such activities as review of HACCP plans, CCP records, critical limits and microbial sampling and analysis. FSIS is requiring that the HACCP plan include verification tasks to be performed by plant personnel. Verification tasks would also be performed by FSIS inspectors. Both FSIS and industry will undertake microbial testing as one of several verification activities.

Verification also includes 'validation' – the process of finding evidence for the accuracy of the HACCP system (e.g. scientific evidence for critical limitations).

Principle 7: Establish record keeping procedures. – The HACCP regulation requires that all plants maintain certain documents, including its hazard analysis and written HACCP plan, and records documenting the monitoring of critical control points, critical limits, verification activities, and the handling of processing deviations.

2. Food and Drug Administration (FDA)

The **Food and Drug Administration** (**FDA** or **USFDA**) is an agency of the United States Department of Health and Human Services, one of the United States federal executive departments. The FDA is responsible for protecting and promoting public health through the regulation and supervision of food safety, tobacco products, dietary supplements, prescription and over-the-counter pharmaceutical drugs (medications), vaccines, biopharmaceuticals, blood transfusions, medical devices, electromagnetic radiation emitting devices (ERED), veterinary products, and cosmetics.

The FDA has its headquarters at White Oak, Maryland. The agency also has 223 field offices and 13 laboratories located throughout the 50 states, the United States Virgin Islands, and Puerto Rico. In 2008, the FDA started opening offices in foreign countries, including China, India, Costa Rica, Chile, Belgium, and the United Kingdom.

The programs for safety regulation vary widely by the type of product, its potential risks, and the regulatory powers granted to the agency. For example, the FDA regulates almost every facet of prescription drugs, including testing, manufacturing, labeling, advertising, marketing, efficacy and safety, yet FDA regulation of cosmetics is focused primarily on labeling and safety. The FDA regulates most products with a set of published standards enforced by a modest number of facility inspections.

3. Environmental Protection Agency (EPA)

The U.S. Environmental Protection Agency (EPA) is responsible for a number of activities that contribute to food security within the United States, in areas such as food safety, water quality, and pesticide applicator training. Through the exchange of expertise, EPA also contributes to food security throughout the world.

EPA's primary contribution to food security is through its program to regulate the use of pesticides. EPA is responsible for ensuring that the American public is protected from potential health risks posed by eating foods that have been treated with pesticides. The Agency is responsible both for the registration of new pesticides before they can be marketed and the re-registration of older pesticides to ensure that they meet current scientific standards.

In the ten years after the passage of the Food Quality Protection Act of 1996, EPA undertook a comprehensive review of tolerances for pesticide residues in food, with an emphasis on increasing protection for infants and children as well as other vulnerable groups.

4. ISI (Indian Standards Institution)

The **Indian Standards Institution** (ISI), set up under the Resolution of the then Department of Industries and Supplies No. 1 Std.(4)/45, dated 3 September 1946. As a corporate body, it has 25 members drawn from Central or State Governments, industry, scientific and research institutions, and consumer organizations. Its headquarters are in New Delhi, with regional offices in Kolkata, Chennai, Mumbai, Chandigarh and Delhi, and 20 branch offices.

Now ISI is the **Bureau of Indian Standards** (BIS). It is the national Standards Body of India working under the aegis of Ministry of Consumer Affairs, Food & Public Distribution, Government of India. It is established by the Bureau of Indian Standards Act, 1986 which came into effect on 23 December 1986.

To support the activities of product certification, BIS has a chain of 8 laboratories. These laboratories have established testing facilities for products of chemical, food, electrical and mechanical disciplines. Approximately, 25000 samples are being tested in the BIS laboratories every year.

Management System Certification

- Quality Management System Certification Scheme IS/ISO 9001
- Environmental Management System Certification Scheme IS/ISO 14001
- Occupational Health and Safety Management System Certification Scheme IS 18001
- Hazard Analysis and Critical Control Scheme IS/ISO 22000
- Service Quality Management System Certification Scheme IS 15700