

**ADVANCEMENT IN FOOD TECHNOLOGY THROUGH RETORT
PROCESSING AND FOOD SAFETY GUIDELINES**Amit Maru* and Pankaj Musyuni[#]

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ABSTRACT: This review is about the improved technology of the retort processing of food and food safety guidelines". The retort processing of food is a process of terminal thermal sterilization of pouched packed ready to eat food. Food is prepared by conventional method and then it is packed in the retort pouch available for different types of food. Finally these pouches are sterilized by using "Retort Process Sterilizers". By using this technology, food can be made available for long time consumption without any harmful effects. Food industry follows various guidelines for the food quality & safety aspects. The main guidelines regarding food are Food Safety and Standard Act, Food Adulteration Act, HACCP Concept, ISO (FSMS) Concept and USFDA: Bacteriological Analytical Manual (BAM).

Keywords: Food contamination, process technology, retorts processing, Food safety guidelines.

INTRODUCTION**Contamination of Food Products**

The physical, chemical or biological agents or any condition of food, which may lead to hazards to health, are called as contaminations. Contaminations in food are of many types, which are described as follows:-

Physical contamination:

Physical contamination is defined as object which damages the food integrity. Physical contaminates may be of anything which is not a part of food, e.g. nails, hairs, stones, soil, stems, seeds etc. Adulteration is also one of the major physical contaminations. It is basically mixing of inferior quality substances to the superior product, which reduces the nature, quality and originality of product in taste, colour, odour and nutritional value and thus resulting in ill effects on the health of the consumers [1].

Chemical contamination:

Chemicals contamination is defined as materials which changes the composition of food. Many chemicals such as pesticides residues, cleaning chemicals, veterinary residues, food additives, coloring matter, preservatives artificial sweetening agents, antioxidants, emulsifiers/stabilizer, flavours/flavour enhancers are used in food preparation and these chemicals may be toxic, when causes harmful reaction, when consumed by animals or humans. The use of chemicals in the production and processing of food and food products not only affects the quality, but also disguises the deterioration, and constitutes deliberate adulteration which is potentially very harmful to the health. It is advised that such chemicals are used in food then should be of approved quality and processed under good manufacturing practices.

Microbiological contamination:

Microbiological contamination is defined as any organism invisible or visible which are harmful to health. Invisible microorganisms include bacteria, yeast, fungi, molds, viruses and protozoa. Microbiological contaminated food is the most prevalent health problem in the modern world. For food safety microbiological criteria should be established and freedom from pathogenic microorganisms in the raw materials, ingredients, production, processing and finished products must be ensured. Consuming old, used, residual, fermented, spoiled, and contaminated, toxic and bacterial infested food causes food poisoning [2].

Gastroenteritis is caused by food contaminated with the enterococcus and streptococcus species, which are frequently found in the human intestinal tract. Poisoning is caused by inadequately refrigerated food contaminated with microorganism. *Clostridium perfringens* grows in the alimentary canal producing the poisoning in 8-12 hours after the ingestion of contaminated food.

Bacillus cereus, a gram positive, aerobic, spore-forming organism has been reported to be the etiologic agent in numerous food poisoning outbreaks. Incidence of liver cancer is high in our country due to Aflatoxins. Lathyrism is a disease, which paralyses the lower limbs. The disease is associated with consumption of Khesari daal and its besan. Its incidence is higher in males than in female.

Metallic contamination:

Metals also cause which contaminate the food. They become toxic, when present beyond small quantities as per standards. They find their way into food through air, water, soil, industrial pollution and other routes. A major source of tin contamination is tin plate, which is used for making containers for all types of processed foods. Canned foods if used in acidic conditions and one stored in tin conditions after opening, change their in colour or develop a metallic flavour that is unpalatable. Metals may enter from utensils, which are used for cooking of food. Copper is an essential trace element required by the human body but it becomes toxic when present in the food in excess amount.

Other contaminants:

Many materials are used for the sterilization of food such as fumigants, in which steam heating is impractical. Ethylene oxide is commonly used fumigant, which reacts with food constituents to produce or destroys essential nutrients. It reacts with inorganic chloride to form ethylene chloro hydride, which is a toxic product for human health. Various solvents are used for the extraction of oil from oil seeds. But solvents like trichloroethylene react with the foodstuff being processed with the formation of toxic products [3].

Lipids presents in food undergo numerous changes on prolonged heating. Reactions such as hydroxylation, hydration, oxidation, reduction and polymerization also take place due to prolonged heating of food. Smoking of meat and fish for preservation and flavoring is an old practice. This processing contaminates the food with polycyclic aromatic hydrocarbons such as benzopyrene, which is carcinogenic in nature. Lubricants, packing materials etc. also contaminate the food.

RETORT PROCESS TECHNOLOGY

Retort processing of foods is the most acceptable stage of food preservation in rigid, semi-rigid and flexible packaging forms. It represents the unique combination of package, process and product technology with potential economical benefits. Retort is a process that uses heat and pressure to cook food in a strong and sealed package. Because the packaging is less bulky than traditional cans and jars, food cooks more quickly, providing a better taste to the product after the container has been sealed [4].

The retort process uses water or steam/air combination as processing medium to heat the container/packages.

Compressed air or additional steam is introduced during the processing cycle to provide the overpressure (any pressure supplied to the retort in excess of that which can be normally achieved under steam at any given retorts temperature). Overpressure is important in preventing package damage or loss of seal integrity (like bursting), during the heating process.

Ready-to-use retort pouches are flexible packages made from multilayer plastic films with or without aluminum foil as one of the layers. Unlike the usual flexible packages, they are made up of heat resistant plastics, thus making them suitable for processing in retort at a temperature of around 121°C. These retort pouches possess toughness and puncture resistance normally required for any flexible packaging. The material is heat sealable and has good barrier properties [5].

The packaging materials such as polypropylene nylon (pp/nylon/pp), polyester cast propylene (pet/cpp) and polyester aluminum foil cast polypropylene (PET/A foil/C.PP) have been evaluated for their mechanical strength to withstand retort conditions at a temperature up to 135°C, oxygen barrier properties, compatibility with the food products and shelf-life of 12 months under ambient conditions. The retort process sterilizer has been designed and fabricated as semi-automatic bulk sterilizer with a capacity of 250 kg batch. It offers many advantages such as rapid heating and cooling, uniform distribution of pressure and temperature and better package integrity by overriding pressure. Since it is indigenous and cost effective, it is affordable to all type of food industry and is suitable for small scale operations. Various vegetarian and non-vegetarian foods products include Sooji Halwa, Upma, Channa Curry, Chicken Curry, Mutton Curry, Fish Curry, Avail, Potato-Peas Curry, Mushroom Curry, Vegetable Pulav, Chicken Pulav, Mutton Pulav, are retort processed food products available in the market for consumption [6].

Advantages of retort pouches:

Retort pouch is acceptable and even superior to glass or metal containers. The pouch has the same shelf-life as the can or the ready-to-cook products packed in flexible plastic pouches jars. The retort pouch provides ease of opening and re-closing (compared to glass jars). The retort pouch can save about 60% energy while processing. Furthermore, as the product is already sterile, it does not require additional low temperature storage. It's stable in nature and requires no refrigeration. It provides larger surface area for providing information on to it. It has more appetizing package presentation. It gives better merchandising options throughout the storage and reduces the storage space. It is lighter and less expensive to ship. It is easy to open heat and use the product [7].

FOOD SAFETY GUIDELINES

The Food Safety And Standards Act (2006):

The Government of India consolidates the laws relating to food and its safety. The Standard Authority of India had laid down certain science based standards for articles of food and to regulate their manufacture, storage, distribution, sale, import and to ensure availability of safe and wholesome food for human consumption and for matters connected therewith or incidental thereto establish act, Act No. 34 of 2006. This Act called as the Food Safety and Standards Act, 2006. The objective of this Act is to bring out a single statute relating to food and thus provide help in systematic and scientific development of food processing industry.

The Act incorporates the salient provisions of the Prevention of Food Adulteration Act, 1954 (37 of 1954) and is based on international legislations, instrumentalities and CODEX ALIMENTARIUS COMMISSION Guidelines. It emphasizes on the responsibility of manufacturers for recall, emergency control, risk analysis, food safety and good manufacturing practices and process control viz., hazard analysis and critical control point [8].

The HACCP concept:

Hazard Analysis and Critical Control Point (HACCP) is a systematic preventive approach to food safety that addresses physical, chemical and biological hazards as a means of food prevention from any type of contamination. Hazard Analysis and Critical Control Point (HACCP) is used in the food industry to identify potential food safety hazards, so that key actions, known as Critical Control Points (CCPs) can be taken to reduce the risk of the hazards. The system is used at all the stages of food production and preparation including raw material purchasing, food processing, food packaging, distribution and consumption of the finished products. HACCP is based on seven established principles, which includes conduct of hazard analysis, its identification and its specific control measures. It also helps in identifying Critical Control Points (CCPs) and in establishment of critical limits at each CCPs, monitoring procedures, corrective action procedures, verification procedures and documentation procedures as appropriate [9,10].

Food safety management system (FSMS):

A food safety management system (FSMS) is a network of interrelated elements that combine to ensure that food does not cause adverse human health effects. These elements include programs, plans, policies, procedures, practices, processes, goals, objectives, methods, controls, roles, responsibilities, relationships, documents, records and resources. A FSMS is often one part of a larger management system [11].

Food safety policy:

A food safety policy statement formally defines an organization's commitment to food safety. It expresses, in general terms, what top management intends to do about food safety and describes the direction for the organization to take. More precisely, a food safety policy statement should express an organization's commitment to the implementation and ongoing maintenance of its food safety management system (FSMS). The food safety policy should drive the establishment of the FSMS and should also encourage people to update and improve its overall effectiveness [11].

The GMP concept:

GMP refers to the Good Manufacturing Practice Regulations promulgated by the US Food and Drug Administration under the authority of the Federal Food, Drug, and Cosmetic Act. The concept of GMP comes under the 21 CFR parts 110 of this Act. These regulations, which have the force of law, require that manufacturers, processors and packagers of drugs, medical devices and food take proactive steps to ensure that their products are safe, pure and effective. GMP regulations require a quality approach to manufacturing, enabling companies to minimize or eliminate the instances of contamination, mix-ups and errors. This in turn, protects the consumer from purchasing a product which is not effective or even dangerous. Failure of firms to comply with GMP regulations can result in very serious consequences including recall, seizure, fines and jail [12, 13, 14].

21 CFR parts 110: Current good manufacturing practice in manufacturing, packing, or holding human food:**Subpart A – General provisions**

As per 21 CFR 110.3, the definitions and interpretations of terms in section 201 of the Federal Food, Drug, and Cosmetic Act, the act is applicable to many terms. It defines about the various terminology used in the food industry such as acid food, canned food, lot, microorganism, moisture level etc.

As per 21 CFR 110.5, the criteria and definitions in this part shall apply in determining whether a food is adulterated or not As per section 402(a) (3) of this Act whether the food has been manufactured under such conditions that it is unfit for food; or within the meaning of section 402(a)(4) of the Act whether the food has been prepared, packed, or held under insanitary conditions whereby it may have become contaminated with filth, or whereby it may have been rendered injurious to health. Food covered by specific current good manufacturing practice regulations also is subject to the requirements of those regulations [15, 16, and 17].

As per 21 CFR 110.10, the plant management shall take all reasonable measures and precautions to ensure the disease control and cleanliness. Any person after medical examination will be employed to industry and the level of cleanliness should be followed as per guidelines.

Subpar B – Buildings and facilities

As per 21 CFR 110.20, the floor and grounds for a food plant under the control of the operator shall be kept in a condition that will protect against the contamination of food. The methods for adequate maintenance of grounds include properly storing the equipments, removing litter and waste, and cutting weeds or grass within the immediate vicinity of the plant buildings or structures that may constitute an attractant, breeding place, or harborage for pests. Maintaining roads, yards, and parking lots so that they do not constitute a source of contamination in areas where food is exposed. Adequately draining areas that may contribute contamination to food by seepage, foot-borne filth, or providing a breeding place for pests. Operating systems for waste treatment and disposal in an adequate manner so that they do not constitute a source of contamination in areas where food is exposed.

As per 21 CFR 110.35, buildings, fixtures, and other physical facilities of the plant shall be maintained in a sanitary condition and kept in safety to prevent food from becoming adulterated within the meaning of the Act. Cleaning and sanitizing of utensils and equipment shall be conducted in a manner that protects against contamination of food, food-contact surfaces, or food-packaging materials.

As per 21 CFR 110.37, the water supply shall be sufficient for the operations intended and shall be derived from an adequate source. Any water that contacts food or food-contact surfaces shall be safe and of adequate sanitary quality. Running water at a suitable temperature, and under pressure as needed, shall be provided in all areas where required for the processing of food, for cleaning of the equipments, utensils, and food-packaging materials, or for employee sanitary facilities. Plumbing shall be of adequate size, design and must be adequately installed and maintained to carry sufficient quantities of water throughout the plant and must properly convey sewage and liquid disposable waste from the plant. Sewage disposal shall be made into an adequate sewerage system or disposed of through other adequate means. Each plant shall provide its employees with adequate, readily accessible toilet facilities. Compliance with this requirement may be accomplished by maintaining the facilities in a sanitary condition and keeping the facilities in good repair at all times. It must provide self-closing doors that do not open into areas where food is exposed to airborne contamination [18, 19, 20].

Subpart C – Equipments

As per 21 CFR 110.40, all plant equipment and utensils shall be so designed and of such material and workmanship that may adequately cleanable, and properly maintained. The design, construction and use of equipment and utensils shall preclude the adulteration of food with lubricants, fuel, metal fragments, contaminated water, or any other contaminants. All equipment should be so installed and maintained as to facilitate the cleaning of the equipment and of all adjacent spaces. Food-contact surfaces shall be corrosion-resistant. They shall be made of nontoxic materials and designed so as to withstand the environment of their intended use and action of food, if applicable, cleaning compounds and sanitizing agents should also be given. Food-contact surfaces shall be maintained to protect food from being contaminated by any source, including unlawful indirect food additives.

Subpart E – Production and Process controls

As per 21 CFR 110.80, all operations in the receiving, inspecting, transporting, segregating, preparing, manufacturing, packaging, and storing of food shall be conducted in accordance with adequate sanitation principles. Appropriate quality control operations shall be employed to ensure that food is suitable for human consumption and that food packaging materials are safe and suitable. Overall sanitation of the plant shall be under the supervision of one or more competent individuals assigned responsibility for this function.

All reasonable precautions shall be taken to ensure that production procedures do not contribute contamination from any source. Chemical, microbial, or extraneous-material testing procedures shall be used where necessary to identify sanitation failures or possible food contamination. All food that has become contaminated to the extent that it is adulterated within the meaning of the Act shall be rejected, or if permissible, treated or processed to eliminate the contamination.

As per 21 CFR, storage and transportation of finished food shall be under conditions that will protect food against physical, chemical and microbial contamination as well as against deterioration of the food and the container.

Subpart G – Defect action levels

As per 21 CFR 110.110, natural or unavoidable defects in food for human use that present no health hazard. Some foods, even when produced under current good manufacturing practice, contain natural or unavoidable defects that at low levels are not hazardous to health. The Food and Drug Administration establishes maximum levels for these defects in foods produced under current good manufacturing practice and uses these levels in deciding whether to recommend regulatory action. Defect action levels are established for foods whenever it is necessary and feasible to do so. These levels are subject to change upon the development of new technology or the availability of new information. Compliance with defect action levels does not excuse violation of the requirement in section 402(a)(4) of the Act that food is not be prepared, packed, or held under unsanitary conditions or the requirements in this part that food manufacturers, distributors, and holders shall observe current good manufacturing practice. Evidence indicates that when a violation exists, they cause food to be adulterated within the meaning of the Act, even though the amounts of natural or unavoidable defects are lower than the currently established defect action levels. The manufacturer, distributor, and holder of food shall at all times utilize quality control operations and reduces natural or unavoidable defects to the lowest level at a feasible level [21, 22].

EXPERIMENTAL TESTING FOR FOOD ANALYSIS

For the safety quality of the food, it must be tested. The testing of food is mostly done for their raw material used and the finished products obtained. In this aspect, many testing parameters are available for different level analysis of food products. Mainly these are unique quality attributes, which are to be studied for the food product testing. Various testing parameters for food analysis are [23, 24, 25]

Raw materials:

Raw material is the basic functional unit of any process. The food is prepared by the materials, which are the constituents of the food.

Physical examination:

This testing involves the food material purity aspects. This is determined by the level of foreign matter, % Ash value, moisture content etc.

Microbiological examination:

The food safety is decided by the level of microorganisms present in it. Hence the level of these will be in the mentioned limits. For food, the entire test for microorganism is performed as for the testing *E. coli*, *Salmonella*, *P. aeruginosa*, *S. aureus* etc.

Packaging material specifications:

The quality of the packaging material decides the shelf life of the food products. Different types of pouch, cans, jars etc. are used for the packaging of food. The material should be safe, non reactive and heat stable. Specifications for the food pouch and cans are discussed in the USFDA 21 CFR part 108, 163, 177.

Finished products:

Packing material (Pouch):

Sealed strength testing and leak integrity testing:

These tests decide that the product packed in the pouch is safe when sealed and are performed in the final product, so there is no contamination occurs in transportation and handling of the food products.

Microbiological analysis:

Microbiological testing shows the levels of different microbes in the food products. Different types of plate count methods decide the level of contaminations of the microbes. The media used for the growth of specific microorganism, so that the identification of the microbes can be done to remove them from the final products to make the food safe for human consumption [26, 27]. Microbiological analysis is performed by various methods:

Aerobic plate counts

Anaerobic counts

Total viable aerobic counts

Total combined yeasts and molds count (TYMC)

Test for absence of Sporforms organism

Test for absence of Coliforms organism

Test for absence of Shigella organism

Test for absence of Salmonella organism

Chemical analysis:

For estimation of “Nutritional Facts” in retort processed food products, test for estimation of total ash, total moisture, crude fiber, carbohydrate, total protein, total fat, saturated fat, cholesterol, total dietary fiber and micronutrient such as iron, calcium, zinc, vitamins etc. are to be performed.

Shelf life and stability:

Shelf-life or shelf stability are the terms used to describe how long a food product will be safe or have suitable quality after the date of manufacture. It is up to the manufacturer to determine how long a product will be good. These are usually expressed as a “Sell by__” date or “Best if used by__” date.

CONCLUSION

India has made lot of progress in agriculture and food sectors since independence in terms of growth in output, yields and processing. It has gone through a green revolution, a white revolution, a yellow revolution and a blue revolution. Today, India is the largest producer of milk, fruits, cashew nuts, coconuts and tea in the world and the second largest producer of wheat, vegetables, sugar and fish and the third largest producer of tobacco and rice in the world. The popularity of ready to eat packed food now is no longer marked for a special occasion. People know value of time and money in terms of quality and variety. The food processing industry is one of the largest industries in India and is ranked fifth in terms of Production, Consumption and Export.

Now the time is to provide better food processing and its marketing infrastructure for Indian industries to serve good quality and safest processed food like ready to eat food. It is opening a new window in world scenario as far as taste and acceptance is concerned. Therefore, Indian Government is providing more infrastructures for this sector. Excise duty is now ZERO % and 100 % tax deduction for the first 10 years for new units. This allows manufactures to bring down their prices and spreads its flavors to the world.

In this era the retort process technology will play a very significant role to rise up the Indian food industries because it gives the whole some technology for the food. By this, food can be used for longer time with safety hand. This type retort products are safe to export and hence lead to growth of economy.

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