Environment and Ecology 36 (4) : 953—958, October—December 2018
Website: environmentandecology.com ISSN 0970-0420

Technological Aspects for Assuring Food Safety in Food Production Chain

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Received 5 May 2018; Accepted 8 June 2018; Published on 25 June 2018

Abstract Food product is monitor by food production chain which initiates from the production and concludes at the consumer. Suitable insurance to the customers in the food chain system is addressed over food security needs. Food safety affirmation comprises of varied approaches laterally the food production chains which include Good Manufacturing Practice (GMP), Good Hygiene Practice (GHP), Hazard Analysis Critical Control System (HACCP). Besides these safety systems, food standard and safety is also authorized through food legislations and permissible criteria for the upper safe limits of microbial contamination or the lower limits of various food components in a commodity at various levels. This method is limited to the ultimate product only and not relevant to the entire chain of food production. In order to overcome this problem various technological approaches have been emerged in current years which can be incorporated with the intention of confirming the food safety in the complete food manufacture chain. This paper thus gives an idea about the different technologies which can be incorporated so as to promise food safety in overall food production chain.

Keywords Food safety, Food production chain, Food quality, Innovative techniques, Consumers.

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Introduction

Food production starts with the output and storage of fresh materials and simultaneously continued with processing, packaging, distribution and finally from preparation to the table at different household of the consumers. To safeguard the concluding process of this food chain sufficient safety needs are implemented and monitored at different levels from

farmers to consumers. This is the key responsibility not solitary to protect the food from causing different health hazards but as well to lessen the post-harvest losses, which is equally significant in those circumstances where food security is vulnerable. In current years food safety methods in the food production chain has augmented its value to a great extent. Globally, many countries have retorted to the food safety awareness actively by developing key approaches encircling the whole production chain (Grunert 2005). Food legislature describes suitable maximum intensities of toxins or contaminants in food commodity. When these are surpassed, safety issues may occur. The initiate of food safety over legal standards is too limiting since it does not include all the aspects linked with entire chain of food production. To overcome these issues several technological tactics have been advanced in current years which can be incorporated with the intention of confirming the food safety in the complete food production chain, leading to sager foods, more nutrition, new flavors, texture, tastes and finally with longer shelf-life (Trienekens and Zuurbier 2008). Furthermore, new progressions, equipment, safety systems, packaging materials and testing procedures will bring about advances in the whole food safety in the food production chain.

Need for food safety

Consumers nowadays are more alarmed about the security of their food because consumers are more educated and informed about food related issues of food scandals and events that have happened in the recent times. It is as well seen that with the change in the life style, the consumers demands associated to the food has also changed. The necessity for the ready to eat, ready to serve and minimally processed foods has increased. This is because the customers have developed a consciousness towards their health shifting for better quality food. there has been a standard transference in the approach of the consumers from quantity to the standard of the food products. With these changes now more concern remains with the security of the food products. In this context governments and the other stakeholders are developing and enforcing fresh legislation and other such possible schemes to upgrade the product quality in an effort not only to guarantee the protection of the products, but as well to raise the consumer community's awareness of their efforts.Therefore, one of the vital issues for almost all the stakeholders in the section of food production chain is the safety and hence, needed to be in the working mode to guarantee the food (Manning and Baines 2004, Busta 2003).

Food safety challenges

There are many challenges faced by the food safety in recent global dimensions, may it be in reduction of food waste or effective utilization of natural resources. Food safety manages protection of food production chain from the life cycle of various harmful microbial and chemical means. Now a days, food production track has grown very complex with the upsurge in the no. of producers, suppliers, processes, products. The longer the food manufacture chain, the extra chances for things to go wrong, results in adverse health consequences for consumers. Proliferation of food production chains combined with climate change contribute to increased incidences of food-borne illnesses and toxins in food which has caused compulsion of identifying evolving food safety concerns and international cooperation. It has also been witnessed that plenty of gaps persists in the application of already existing laws and regulations which also contribute to safety concerns in the production chain. New food production and resource approaches offer the possibility of outbreak and a change in epidemiology for large and widespread food-borne disease in food safety systems (Trienekens and Zuurbier 2008). Therefore, the crucial feature to protect the food in every steps of food production, form farm to plate, is through food safety. This integrated approach laterally the food production line should be utilized to prevent risk and encourage and implement orders so as to achieve safety in production chain.

Need for technological approach

Technological approaches are different for nearly every food product in the complete production chain. Official support is often required for consumers concerns regarding food safety and solving the is-

sues of food quality. With rapid distribution methods in the global delivery of food, serious public health risks and food hazards in some part of the world can be shifted to other parts of the world in a very short time. Customers assume government agencies to make sure that safe food is produced and threats to human health are minimized. But in emerging countries due to lack of latest knowledge, information and resources, government fails in providing financial and technical support for assuring safety of food. There are also methods, facilities and equipment, for testing or analyzing food for toxins, contaminants, microbial or chemical contamination (Grunert 2005). Thus there is direct requirement for enhanced regulatory food examination and laboratory facilities for food control execution programs in emerging countries. In general overall technological intervention necessities should be initiated in the complete production chain for promising the security in food production chain.

Techniques for assuring food safety

The safety and the standard of the food stuffs should be a vital target in the food production chain. There are various improved and innovative methods so as to develop the product standard and safety with an aim to preserve the nutrients, improve the sensory properties and enhance shefe-life of food commodity (Hobbs et al. 2002). Some of the techniques to assists these objectives include Pulsed Electric Field Technology, Ohmic Heating, Ozone Treatment, Microwave Heating, Ultrasonics, High Pressure Processing, Pulsed Light Technology and Oscillating Magnetic Fields and Irradiation Technology. With the intention of minimizing the risk of contamination or intoxication related with the food commodity and ensuring an overall safety during the complete production chain, selected best possible techniques are discussed in this section.

Ozone treatment

Ozone is a dominant antimicrobial and sporicidal agent. Ozone is considered as the utmost effectual sanitizers, and it leads to an impulsive decomposition to a non-toxic product. Ozonized water is extensively utilized as sanitizer and is very effectual in extending shelf-life of fruits and vegetables. Ozone has been acknowledged as GRAS by FDA as antimicrobial agent in dealing with raw and fresh vegetables and fruits produce in gas and aqueous phases. This is the simplest techniques which can be utilized so as to render food safe (Rice et al. 2002).

Microwave heating

In microwave heating, heat is produced through electromagnetic waves of certain frequencies. The food at the edge of the container, placed inside the microwave, gets heated faster and a temperature gradient is developed between the center and edges. Most frequently used frequencies used for food products are 2450MHz and 915MHz. Despite of the concern of ununiformed heating which is a note worthy technical hurdle, the process shows significant potential when combined with other techniques for improves and safer foods (Tang et al. 2002). Food commodity, such as pre-cooked foods, bread and animal feed stuffs has been treated by means of microwaves for pasteurization or sterilization. Some of the other process which can be dome using microwave are pasteurizing, concentration, curing, drying, baking, freeze drying, sterilizing, tempering, cooking thawing and finish drying.

Pulsed electric field

This technique facilitates the high voltage electric pulses (upto 70 kV/cm) into the food produce when positioned amongst two electrodes for limited micro seconds. It was observed that to surpass a critical transmembrane potential of one volt, external electric field strength of 10 to 20 kV/cm is used which facilities speedy electric breakdown and rupture of cell membranes, which causes the discharge of intracellular liquid, and cell death (Pal 2017). Microbial treatment is as well possible through the uneven electrical charge across the cell membrane leading to inactivation. To evade damage and avert off-flavor to the food commodity from heat, treatment temperature is retained as low as possible. This technique is applicable in baking applications, processing of orange juice, milk, apple juice and processing of green pea soup, which is very effective in

attaining foremost quality and extended shelf-life.

High pressure processing

High pressure processing utilizes pressure upto 900MPa, even at room temperature, for killing microorganisms in food commodity without degrading the color, flavor and vitamins. It is also known as High Hydrostatic Pressure or Ultra High Pressure processing. Generally, 350MPa for 30 min or 400MPa for 5 min causes ten fold reduction in vegetative cells of yeast, bacteria and molds. Very high pressure can generate little heating to the product with destruction of spoilage and pathogenic organisms i.e., 50000 to 120000 PSI, whereas pressure gets promptly and evenly distributed when 1000MPa pressure is applied to the food packages, submerged in a liquid (Fonberg-Broczek et al. 2005). Combination of mild heating and high pressure cause inactivation of more fragile bacteria. Sterilization of heat subtle components like shellfish, flavorings, and vitamins, pasteurization of fruits and fruit commodity, vegetables and meat, pickles, sauces, yoghurt, can be done using the above technique. It leaves no trace of toxicity, rather reduces the processing time, maintains the freshness, nutrients, flavor, color and destroys the vegetative bacteria and spores (Considine et al. 2008). There is uniformity of treatment throughout the food product.

Pulsed light / High intensity light technology

This is a cleansing or sterilization technique, also acknowledged as pulsed broad spectrum white light, which is utilized for inactivation of microbes on food exteriors, food packaging stuffs and equipments. Sterilization on food surface is done using high intense white light which is pulsed between 10^{-8} and 10^{-1} cycles per second. Destruction of microbes is done through fast heating, with no actual cooking, and photochemical mechanism (Abida et al. 2014). It is a non-thermal treatment with higher levels of energy, treated to inactivate bacterial spores in addition to vegetative cells. It also minimizes the damaging consequnce of the thermal processing and chemical action on quality attributes. Application of this method used in food processing emits one to 20 flashes per second of electromagnetic energy which is utilized in sterilization of dairy products, water, vegetables, equipment surface and cleanliness of packaging materials.This technology is predicted to be evolved for future surface treatment of food and packaging material, guaranteeing the safer and standard food products.

Ohmic heating

In this technique electricity is distributed through an electrically conducting surface, transforming electrical energy into heat. Disparate conventional technique of food processing, ohmic heating is effectual in processing food with large solid particulates. Heat is produced when electric current is directly conducted through the food, destroying the microbes similar to thermal (Cappato et al. 2017). Use of this method on different food product depends on its electrical conductivity. This technology is used in dehydration, blanching, dehydration, evaporation, value addition of processes, dehydration and extraction. Upcoming uses, such as for aseptic food products, are likely to take advantage of the exclusive attribute of a process that comprises both the even heating of particles and the suspension of fluid collectively (Ramaswamy et al. 2014). In the future, expressed foods could be pre-served by heating the suspended solids and liquids at diverse process streams and united later.

Ultrasonics

This is also known as supersonic having frequency greater than 20 kHz. Ultrasound when combined with reasonable heat aids in inactivation of microorganism. It has an immense application in drying, usually done at low temperature reducing the possibilities of degradation or oxidation in contrast to conventional methodology. Ultrasound has probable use for emulsified foods, particularly where a products rheological assets can be enhanced by ultrasound treatment. Heat transfer between the solid heated exterior and liquid is enhanced by roughly 30-60% by engaging ultrasound technique (Chemat and Khan 2011). Ultrasonics can be used in pasteurization at mild heat, extraction, enzyme inactivation, emulsification, crystallization, viscosity alteration and de-

gassing spraying or coating, anti-fouling and defoaming. This is an evolving technique and can performance a noteworthy role in food safety features for example, extraction, emulsification, anti-fouling, crystallization, spraying, coating and viscosity alternation.

Irradiation

Persistent increase in food loss due to manifestation, contamination and spoilage and rising distresses over food-borne diseases gave rise to emergence of the above technique. This process not only assists as a conservation technique for post-harvest damages owing to insect manifestation and premature germination, but also supports in reducing the dependency on chemical pesticides. For roots and tubers, germination is the chief reason of damages. Radiation processing proposes a substitute to fumigation and certain additional treatments which is advantageous in decreasing the bacteria populations. The irradiation effect penetrates the product and eliminates microorganisms that are found in the food products. Microbial and pathogen amounts can be considerably declined by low-dose irradiation deprived of disturbing sensory attributes. The irradiation of vegetables and fruits is approved by US-FDA to a maximum of lkGy for disinfection (Smith and Pillai 2004). It is a favorable technique that can be utilized to boost the safety of food commodity.

Modified atmosphere packaging (MAP)

Modified atmosphere packaging of food stuffs is an extensively used technique for fresh foods, ready to eat foods and baked commodity. The uniqueness of this application is the usage of inert gases, vacuum and reactive gases to control the microbes boost the shelf life and maintain freshness of the product. Packaging material can have properties other than its customary hurdle properties for oxygen regulator, moisture regulator and light restriction and against insect manifestation (Church and Parsons 1995). Modified atmosphere packaging (MAP) has been utilized to elongate the shelf-life of vegetable and fruits by reducing respiration rate and delaying senescence. The objective of this principle is to build optimum gas equilibrium exclusive package, where the respiration action of a produce is as low as possible, but the intensities of carbon dioxide and oxygen are not injurious to the commodity.

Active packaging

Active packaging comprises numerous gas absorbents and emitters and is considered as the significant packaging means for fruits and vegetables. It is probable to influence respiration activity, plant hormone activity and microbial activity by accurate active packaging. The utilization of an active system, with a package engineered to scavenge molecules as O_2, CO_2 and ethylene finds good applications in vegetable and fruit sector (Hosseinnejad 2014). The utmost significant O_2 scavengers are related to the oxidation of ferrous ions; other active agents are unsaturated fatty acids, ascorbic acid, and enzymes.

Conclusion

It has turn out to be obvious that with the increasing awareness of food security within a food production chain, implementation of new and advanced food safety techniques alongside the supply chain in different regions needs knowledge not only from food safety research but also acceptance of indigenous practices, context and environmental conditions. The main motive for implementing these emerging innovative food security techniques is not only the guarantee of microbial decline on the commodity at various stages of production but also superior and safer standard of the foods produced. High resources are usually essential to precede the tailor-made investigation on these new processing approaches, but the outcomes of this fundamental research are encouraging. Applications of the technologies to utilize it further than protection or safety have been studied to improve great value-added practices or to classify additional saving prospects which can be done by incorporating novel techniques at various steps in the food production chain, integrated with the improved food inspection approaches, upgraded laboratory services and better food control implementation programs will definitely lead to the guarantee of safety in the complete production chain.

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