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Review Article

Biocontrol of food contamination

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ABSTRACT

It is important to understand what the potential hazards that comes to food safety. Food contamination refers to food that has been corrupted by another substance – either physical, biological or chemical. Biological contamination refers to food that is contaminated by organisms or substances they produce. This includes biological matter produced by humans, rodents, insects and microorganisms. Bacteria and viruses are typically the two biggest causes of biological contamination and can result in the most common types of food poisoning including salmonella, *E .coli*, listeria and Norovirus. Thoroughly washing your hands and sanitizing the food handling equipment are two of the best ways for prevention of bacterial contamination. Physical contamination occurs when a foreign object contaminates food. This can happen at any stage of the production process and could include glass, steel wool or pieces of plastic Chemical contamination refers to food that has been contaminated with a natural or artificial chemical substance. These contaminants are particularly dangerous as they expose people to any number of toxic substances, some of which could be fatal.

1. INTRODUCTION

Food safety is one of the major concerns due to threatening human health by various food-borne pathogens. Food preservatives can be intimidating and have long, complex chemical names on food labels. Some preservatives have been accused of causing cancer. Surprisingly, most preservatives are naturally found in healthy food like fruits and vegetables. It is safer to eat preservatives than risk eating foods infected by bacteria and fungi.

Preservatives help fruit, vegetables and meat stay colorful and appetizing. The flavors of some foods are even enhanced from preservatives. They also prevent infections from bacteria, fungi and some viruses (Howe et al., 2015).

Bio-preservation could be defined as compounds, from natural sources or formed in food, able to prevent or retard spoilage related with chemical or biological deterioration that prolong product shelf life. According to this approach bio-preservation could have been used since ancient times, when fermentation emerged.

Bio-preservation is by using natural or controlled microbiota or antimicrobials. The fermentation products as well as beneficial bacteria are generally selected in this process to control spoilage and render pathogen inactive (Nikfar et al., 2009).

The Food and Drug Administration is in charge of testing and monitoring preservatives to make sure that they will not damage your body. Not only are preservatives regulated in human food, they are monitored in animal food as well. The majority of preservatives have been proven safe for consumption before they get to your plate.

Ascorbic acid can act as an antioxidant for food by preventing browning and discoloration. It is commonly used in fruits, according to an article from Utah State University (Ubeda et al., 2011).

While their names are incredibly similar, sodium nitrate and nitrite serve different purposes. Sodium nitrite is commonly found in cured meats, such as bacon. It is often used in deli meats to preserve the color of the meat. Beyond aesthetic purposes, sodium nitrite can actually keep you safe from a nasty bacteria called C . botulinum, which causes botulism (Ubeda et al., 2011).

Benzoic acid is naturally occurring in plants. There is a particularly high concentration in some berries. It is also found in some animals and their milk.

Benzoic acid is used as a preservative in some drinks, baked goods and condiments. It is also used in some toothpaste and mouthwash products, although the taste can be off-putting in high doses .

Sodium benzoate is more water soluble than benzoic acid, making it the preferred preservative for beverages like soft drinks. It is also used in pickle and fruit juice. It acts as a microbial to kill germs and retain the flavor of food (Ubeda et al., 2011).

2. SCIENTIFIC BACKGROUND

2.1. Sources of food contamination.

Food products are rich in nutrients required by microorganisms and may become contaminated. Major contamination sources are water, air, dust, equipment, sewage, insects, rodents, and employees.

Contamination of raw materials can also occur from the soil, sewage, live animals, external surface, and the internal organs of meat animals **(**Gaur *et al*., 2007).

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Additional contamination of animal foods originates from diseased animals, although advances in health care have nearly eliminated this source. (Rodríguez-Hernández *et al*., 1997).

Contamination from chemical sources can occur through accidental mixing of chemical supplies with foods. Ingredients can contribute to additional microbial or chemical contamination.

Contamination can be reduced through effective housekeeping and sanitation, protection of food during storage, proper disposal of garbage and litter, and protection against contact with toxic substances (Viktor *et al.*, 2004).

2.2 Types or forms of food contamination.

There are three different types of food contamination - chemical, physical and biological. (Boa *et al*.,2004).

All foods are at risk of becoming contaminated, which increases the chance of the food making someone sick.

Chemical contamination refers to food that has been contaminated by some type of chemical substance. Because chemicals can be very useful when cleaning in the kitchen, they can easily contaminate food. Chemicals must be properly labelled and stored separately for foodstuff to minimize the risk of contamination (Abdel-Shafy *et al*., 2015).

There are also chemicals that occur naturally in foods, like toxins in some fish, and in some cases, minimal chemical contamination might not actually lead to illness. However, the food handler must always be aware of the presence of chemicals in food and take all reasonable precautions to make sure that chemical contamination does not happen.

Biological contamination refers to food contaminated by substances produced by living creatures such as humans, rodents, pests or microorganisms. This includes bacterial, viral or parasitic contamination that is transferred through saliva, pest droppings, blood or faecal matter. Bacterial contamination is thought to be the most common cause of food poisoning worldwide, and the best way to protect against it occurring is by maintaining the best food safety practices (Callejón *et al*., 2015).

Physical contamination refers to food that contaminated by a foreign object at some stage of the production process. These objects have the ability to injure someone and can also potentially carry harmful biological contaminants, which then cause illness. An additional consequence of physical contamination is the upset caused to the person who finds the object. (Louis *et al*., 2016).

2.2.1 Chemical contamination.

The phrase chemical contamination is a clear indication of the presence of chemicals where they should not be or are present in an amount that is in a higher concentration than the amount that is attributed as safe. The chemical hazards are the main causes of food contamination that associated with foodborne disease outbreaks (Faille *et al*., 2013).

Furthermore, food contamination has become more serious in recent years due to the development of industry and the consequent environmental pollution (Song *et al*., 2017).

Besides that, the ingestion of contaminated food with pesticides and heavy metals could cause gastrointestinal infections (Song *et al*., 2017).

For instance, an estimated 400 to 500 children died of acute lead poisoning due to ingestion of food contaminated with lead-contained soil and dust in Nigeria (Tirima *et al*., 2013).

2.2.2 Physical contamination.

Physical contamination occurs when a physical object enters food at some stage of the production or preparation process. Physical objects in food can be a choking hazard and often introduce biological contaminants as well. Even if the object is not likely to injure customer, finding an object in their food can be very distressing for a customer (Song *et al*., 2017).

2.2.3. Biological (Microbial) contamination

Biological contamination occurs when food becomes contaminated by living organisms or the substances they produce. This includes biological matter produced by humans, rodents, insects and microorganisms. Biological contamination is the leading cause of food-borne illness and food poisoning, and a common cause of food spoilage and food waste. There are six types of microorganisms that can cause food-borne illness: bacteria, viruses, parasites, protozoa, fungi and prions **(Callejón *et al*., 2015).**

Most food-borne illnesses are caused by the most common beings:

- Norovirus
- Listeria
- Salmonella
- Campylobacter

2.3 Biocontrol (Biopreservation).

For the Environmental definition of biocontrol is 'Using biological means such as parasite viruses or predators to control a pest' (Pce ., 2010).

2.3.1 Prebiotics.

In 2008, the 6th Meeting of the International Scientific Association of Probiotics and Prebiotics (ISAPP) defined "dietary prebiotics" as "a selectively fermented ingredient that results in specific changes in the composition and/or activity of the gastrointestinal microbiota, thus conferring benefit(s) upon host health (Gibson *et al*., 2008).

The following criteria are used to classify a compound as a prebiotic: (i) it should be resistant to acidic pH of stomach, cannot be hydrolyzed by mammalian enzymes, and also should not be absorbed in the gastrointestinal tract, (ii) it can be fermented by intestinal microbiota, and (iii) the growth and/or activity of the intestinal bacteria can be selectively stimulated by this compound and this process improves host's health. (Gibson *et al*.,2008).

There are many types of prebiotics such as Fructans, Galacto-Oligosaccharides, Starch and Glucose-Derived Oligosaccharides, Non-Carbohydrate Oligosaccharides. The majority of them are a subset of carbohydrate groups and are mostly oligosaccharide carbohydrates (OSCs), but there are also some pieces of evidence proving that prebiotics are not only carbohydrates.(Louis *et al*.,2016).

Prebiotics may have similar safety concerns. The major safety issue of probiotics includes the risk of bacteremia, sepsis or endocarditis, especially in patients with prominent immuno-deficiency (e.g., HIV, cancer, transplant), severe malnutrition or incompetent intestinal epithelial barrier (e.g., severe diarrhea, NEC) (Tsai *et al*., 2019).

It is noteworthy that, these potential complications have not been considered or at least reported in relevant clinical studies exclusively for prebiotics.

2.3.2 Probiotics.

Probiotics are defined as "live microorganisms which when administered in adequate amounts confer a health benefit on the host" (FAO, 2013)

Guidelines and information from the Food and Agriculture Organization of the United Nations (FAO)/World Health Organization (WHO) demonstrate the necessity for the probiotic strains to remain intact through the upper intestinal tract to ensure health promoting effects upon entering their site of action, regardless the delivery mode applied. For instance, to assure that, it has been stated that the so called "minimum therapeutic" level of viable probiotic microorganisms should be at least 10^6 CFU/g of viable cells throughout the product shelf-life (Neffe-Skocińska *et al*.,2018).

Food-based probiotic products account for a large number of probiotic formulations and can be divided in two distinct categories: Dairy products e.g., cheeses, yogurts, ice cream, milk, acidified milks and creams and non-dairy products, e.g., meats and meat products, bread or other fiber snacks, chocolates, fruit juices and other fruit preparations (Eor *et al*.,2018).

Not all probiotics are the same, Different strains of the bacteria as Leuconostoc spp., Lactobacilli spp. and Micrococci spp. have different effects (Eor *et al*., 2018).

Research has been promising for these friendly critters. Potential benefits of probiotics have been seen in the treatment or prevention of diarrhea, irritable bowel syndrome, ulcerative colitis, Crohn's disease *H. pylori* infections and vaginal infection.

Food safety is one of the major concerns due to threatening human health by various food-borne pathogens. Every year in the United States, about 9.4 million cases of foodborne illness with about 56,000 hospitalizations and 1,300 deaths caused by major food-borne pathogens including Salmonella, *Clostridium perfringens*, *Listeria monocytogenes*, and *Campylobacter* have been reported (Scallan *et al*., 2011).

Chemical, physical and biological agents transmitted by foods cause more than 200 recognized diseases in people, of these infectious biological agents are the most important, causing the majority of foodborne disease (Bryan, 1982). Global outbreaks of foodborne disease can have socio-economic impacts on consumer food choices and other behaviour (Knowles *et al*., 2007).

In addition, new pathogens have emerged to correspond with a changing food supply, an increase in the number of people with heightened susceptibility to foodborne diseases and a greater diversity of food preparation practices and food preferences. This has posed a number of challenges for the veterinary profession, Food processors and public health agencies (Epp and BeVier, 2008).

Moreover, with increasing consumer awareness on healthy consumption, tendency to consumption of natural/minimally processed foods that are free from chemical substances is increasing. Therefore, food manufacturers give a priority to the use of natural additives in food processing to meet customer acceptance and fulfill legal obligations. The success of modern food processing technology is dependent on the application of preservation technology without changing food quality throughout the stages until its consumption (Ross *et al*., 2002).

The current technologies employed to inactivate bacterial pathogens on foods are not foolproof, leaving room for new approaches for improving food safety (Hudson *et al*., 2005).

Biocontrol is the use of one or more microorganisms to inhibit or control other organisms. The control may require a living organism, effecting by indirect actions or agents (such as the production of bacteriocins). Biocontrol is related with the activities of the lactic acid bacteria, probiotics, bacteriocins, endolysins, bacteriophages, and "protective cultures" and the others. Some of the biocontrol-based preservations are microbial interference, lactic acid antagonism, bacteriocin production, endolysis information, and bacteriophages.

The most critical criterion for the success of a biocontrol product is whether or not it performs effectively under commercial conditions and provides an acceptable and consistent level of control of the target disease(s) (Schnürer and Jonsson, 2011).

Large-scale production of a formulated biocontrol agent is required in order to conduct meaningful tests. These are costly trials to conduct and most often are done in association with a private company wishing to commercialize the biocontrol product (Sundh and Melin, 2011).

5. CONCULSION

Using of biocontrol methods and approaches to control food contamination have been grown in the past 20 years from a novel discovery to a full-fledged science. Research groups worldwide are identifying new microbial isolates, evaluating their potential as biocontrol agents and seeking to partner with industry. While it was predicted that the success of biocontrol would be relatively easy compared with conventional agents, to date only a few commercial products are available, and these are used only on a very limited basis. The reasons for the limited success are several, but are mainly due to variability in the performance of antagonists, the availability of several standard and new synthetic agents that perform well, and reluctance on the part of end users to adopt new approaches and methods that may or may not be easy to incorporate into existing practices. In addition, problems associated with the patenting, registration and large-scale fermentation of the agents has also posed difficulties. Despite these challenges, interest in the use of biological approaches to manage and reduce contamination in food, as well as other agricultural needs, continues to grow. Researchers, regulatory groups and environmental advocates are coming together to define the problems that need to be dealt with and the scientific knowledge that will be needed to address the barriers limiting success. It is anticipated that great strides will be made in the next 10 years

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