CODEN [USA]: IAJPBB ISSN : 2349-7750

INDO AMERICAN JOURNAL OF
PHARMACEUTICAL SCIENCES
SJIF Impact Factor: 7.187

Available online at: http://www.iajps.com *Review Article*

A REVIEW ON FOOD- SAFETY AND MICROBIOLOGY

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Abstract:

Food Microbiology deals with the study about the microorganisms that cause spoilage of food. The major focus of food microbiology is food safety. Microbial toxins are also possible contaminants of food. pathogenic microorganisms can cause infections and include bacteria viruses, parasites and moulds. There are many different types of bacteria that contribute to food spoilage and of course, there are specific types of bacteria that are used beneficially for fermentation various foods have inherent antimicrobial components that prevent the attack of various foodborne pathogens. Food is the best source of nutrition for microbial growth. The scope of food microbiology is expanding rapidly to protect food from microbial spoilage and provide safe, nutritious food to consumers. Microorganisms play in the production, preservation and safety of foods. Food preservation aims at inactivating and controlling the growth of spoilage and pathogenic Microorganisms, insuring shelf stable and healthy foods.

Food storage and preservation methods helps prevent outbreaks of foodborne illness, resulting from the consumption of contaminated food.

Keywords: Food microbiology, Microbial enzymes, Toxins, Nutrition, Spoilage.

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Please cite this article in press V. S. Chandrasekaran et al, ***A Review On Food- Safety And Microbiology..,*** *Indo Am. J. P. Sci, 2022; 09(12).*

1. INTRODUCTION:

Food microbiology studies the role of microorganisms in foods as well as the use of microorganisms for production of ingredients and foods. Some microorganisms are beneficial in that they cause desirable changes in the food through the process of fermentation, In case of food safety inventions, the "good" microorganisms are often used to fight the" bad" one. The science of understanding these two types of microorganisms is called Food microbiology.[1] The" Food "section of Frontiers in microbiology" could provide good guidance through its RTs on new advances. Microorganism that inhibits, create and contaminate the food It deals with article on different aspects of food preservation, food spoilage, food intoxication, food borne diseases. It even deals with the study use about the microorganisms that cause the spoilage of food. probiotics is one of the most important aspects of food science. The major focus of food microbiology is food safety. In order to ensure food safety, microbiological testing of food products such as testing for pathogens and organisms are necessary. Foods are not only of nutritional value to those who consume but often are ideal Culture media for microbial growth. There are many organisms naturally present in foods. The potential of microorganisms to spoil foods rests on their ability to produce metabolites that are associated with rejection by consumers. Microorganism that inhabits, create and contaminate the food. Continuous monitoring of food contaminants and the identification of risk factors are crucial for assuring food safety [2,3].

2. MICROORGANISMS IN FOOD

Microorganisms In relation to food can have one of these tree roles. Pathogenic microorganisms can cause infections or intoxications and include bacteria, viruses, parasites and moulds. Saprophytic microorganisms play a role in biodegradation and cause food spoilage. Cultured microorganisms like probiotic bacteria are used in food processing.[4] Microorganisms have many beneficial and harmful effects on human life.in addition to being a disease factor in humans, they also cause spoilage in food products. There are many different types of bacteria that contribute to food spoilage and, of course, there are specific types of bacteria that are used beneficially for fermentation. "Commercially, when someone is developing a valid fermentation process, they are typically going to be looking to see that sufficient acid is produced during fermentation, to inactivate some of these acids tolerant(bacteria)" [5].

2.1. Preservation of food

One of the most important goals of the food scientist is to make foods as safe as possible whether they are used fresh or processed. The judicious application of food processing, storage and preservation methods helps prevent outbreaks of foodborne illness, that is the occurrence of disease or illness resulting from the consumption of contaminated food. Food preservation is an action or method of designed to maintain foods at a desired level of quality. Food preservation has been practiced for centuries, with salting generally recognized as the earliest form of preservation. Several intrinsic and extrinsic factors associated with foods serve to promote preservation, the most important of which include: water activity (a_w), temperature (low or high), preservatives (i.e., nitrite), acidity (pH), competitive microorganisms (i.e., lactic acid bacteria), and redox potential (Eh). These extrinsic and intrinsic factors are limited when applied singly. Food preservation helps to reduce dietary deficiencies. Preserved foods help to add variety to the diet. For example, due to arid soil conditions in several Middle Eastern nations, no vegetables are grown. This shortfall is compensated for by importing fresh and preserved fruits and vegetables.[6]

3. FACTORS AFFECTING MICROBIAL GROWTH

3.1 pH

In general, Molds and yeasts can grow at lower pH compared to bacteria and Gram-negative bacteria are more sensitive to low pH than Gram-positive bacteria. The pH range of growth for Molds is 1.5 to 9.0; for yeasts 2.0 to 8.5; for Gram-positive bacteria 4.0 to 8.5; and for Gram-negative bacteria 4.5 to 9.0. Based on the pH ranges, microorganisms can be grouped as:

1.Neutrophiles grow best at a pH range of 5 to 8.

2.Acidophiles grow best at a pH below 5.5.

3.Alkaliphiles grow best at a pH above 8.5.[7]

3.2 WATER ACTIVITY

Water activity (aw) is the amount of water available for biological functions which can be reduced by an osmotic effect. Water in food is made available in various ways such as

1. Solutes and ions tie up water in the solution
2. Hydrophilic colloids
3. The water of crystallization or hydration

Microorganisms need water in an available form to grow in the food. The water activity of food can be expressed by the ratio of the water vapor pressure of the food to that of pure water at the same temperature. It ranges is >0 to <1, because no food can have a water activity of either 0 or 1.[8]

Based on water activity range, microorganisms can be grouped as

- **Halotolerant** that can grow in the presence of high concentrations of salt
- **Osmotolerant** that can grow in the presence of high concentrations of unionized organic compounds such as sugars
- **Aerotolerant** that can grow on dry foods.[9]

3.3 Oxidation-reduction potential (Eh:)

The oxidation-reduction or redox potential of a substance is defined as a measurement of a transfer of electrons between atoms or molecules. The oxidation-reduction potential is usually written as *Eh* and measured in terms of millivolts (mV). The redox potential of food depends on the

1. pH of the food
2. Availability of oxygen (physical state, packaging)
3. Poising capacity or buffering capacity
4. Food composition (such as protein, ascorbic acid, reducing sugars [10]

The Eh range at which different groups of microorganisms can grow are as follows:

1. **Aerobes** that can grow best at +500 to +300 mV such as Molds, yeasts, Bacillus, Pseudomonas, Moraxella, and Micrococcus.
2. **Facultative anaerobes** that can grow best at +300 to +100 mV such as the lactic acid bacteria and those in the family Enterobacteriaceae.
3. **Anaerobes** that can grow best at +100 to –250 mV or lower such as Clostridium spp.[11]

3.4 Nutrient Content:

The microorganisms need nutrients such as proteins, carbohydrates, sulfur, phosphorus, vitamin, lipids, water, energy, nitrogen, and minerals for their growth and to carry out metabolic functions. Food is the best source of nutrition for microbial growth. Microorganisms that are commonly found in food vary greatly in nutrient. The simple carbohydrates and amino acids are utilized first, followed by the more complex forms of these nutrients. The nutritional requirements of Gram-positive bacteria are higher compared to yeasts and then followed Gram-negative. Molds have the lowest nutrient requirements.[12]

3.5 Presence of Antimicrobial Constituents:

Various foods have inherent antimicrobial components that prevent the microbial attack of various foodborne pathogens. The food of plant and animal products contains antimicrobial components. Some foods have a biological structure that prevents microbial entry. The natural covering protects from damage and reduces the chance of microbial spoilage**.** Structures such as the outer coverings on fruits, the shells of nuts, and shells of eggs, meat has fascia, and skin that prevents the entry of foodborne pathogens and spoilage microorganisms.

3.6 Temperature for Storage

The enzymatic reactions and microbial growth are affected by the environmental temperature. growth temperatures for yeasts and molds demonstrate a broad range of 10–35° C.

Based on temperature, bacteria can be grouped as

1. **Psychrotrophs** are cold-tolerant and ubiquitous microorganisms that can grow in a temperature range of 0–20°C. These include *Pseudomonas* spp and *Enterococcus* spp.
2. **Mesophiles** are microorganisms that can grow between 25°C and 40°C, with an optimum growth temperature close to 37°C. These include species of *Salmonella*, *Staphylococcus*, *Clostridium*, *Shigella*, and *Bacillus.*
3. **Thermophiles** are microorganisms that grow at a high temperature above 45°C, with an optimum growth temperature between 50°C and 70°C. These include the species of *Bacillus*, *Clostridium*, and *Geobacillus*

3.7. Relative Humidity

The relative humidity is the amount of moisture in the atmosphere or food environment. Relative humidity can influence the water activity (aw) level on the food and hence can influence the growth of microorganisms. For example, dry grains stored in an environment with high humidity will take up water and undergo Mold spoilage.[13]

4. Foodborne Illnesses

Foodborne illnesses are infections or irritations of the gastrointestinal (GI) tract caused by food or beverages that contain harmful bacteria, parasites, viruses, or chemicals. The GI tract is a series of hollow organs joined in a long, twisting tube from the mouth to the anus. Common symptoms of foodborne illnesses include vomiting, diarrhoea, abdominal pain, fever, and chills. Most foodborne illnesses are acute, meaning they happen suddenly and last a short time, and most people recover on their own without treatment. Rarely, foodborne illnesses may lead to more serious complications.

4.1 Bacteria

Bacteria are tiny organisms that can cause infections of the GI tract. Not all bacteria are harmful to humans. Some harmful bacteria may already be present in foods

when they are purchased. Raw foods including meat, poultry, fish and shellfish, eggs, unpasteurized milk and dairy products, and fresh produce often contain bacteria that cause foodborne illnesses. Bacteria can contaminate food—making it harmful to eat—at any time during growth, harvesting or slaughter, processing, storage, and shipping.

Fods may also be contaminated with bacteria during food preparation in a restaurant or home kitchen. If food preparers do not thoroughly wash their hands, kitchen utensils, cutting boards, and other kitchen surfaces that come into contact with raw foods, cross-contamination—the spread of bacteria from contaminated food to uncontaminated food—may occur. Examples include • Salmonella, a bacterium found in many foods, including raw and undercooked meat, poultry, dairy products, and seafood. Salmonella may also be present on egg shells and inside eggs.[14]

4.2 Viruses

Viruses are tiny capsules, much smaller than bacteria, that contain genetic material. Viruses cause infections that can lead to sickness. People can pass viruses to each other. Viruses are present in the stool or vomit of people who are infected. People who are infected with a virus may contaminate food and drinks, especially if they do not wash their hands thoroughly after using the bathroom. Common sources of foodborne viruses include

- Food prepared by a person infected with a virus
- Shellfish from contaminated water
- Produce irrigated with contaminated water Common foodborne viruses include
- Norovirus, which causes inflammation of the stomach and intestines
- Hepatitis A, which causes inflammation of the liver

4.3 Parasites

Parasites are tiny organisms that live inside another organism. In developed countries such as the United States, parasitic infections are relatively rare.

Foods that come into contact with contaminated water during growth or preparation can become contaminated with these parasites.

Trichinella spiralis is a type of roundworm parasite. People may be infected with this parasite by consuming raw or undercooked pork or wild game.

5. FERMENTED FOODS

5. 1 Kefir

Kefir is a fermented milk product (made from cow, goat or sheep's milk) that tastes like a drinkable yogurt. Kefir benefits include providing high levels of vitamin B12, calcium, magnesium, vitamin K2, biotin, folate, enzymes and probiotics. Kefir has been consumed for well over 3,000 years. The term kefir was started in Russia and Turkey and means "feeling good."

5.2. Kombucha

Kombucha is a fermented drink made of black tea and sugar (from various sources like cane sugar, fruit or honey). It contains a colony of bacteria and yeast that is responsible for initiating the fermentation process once combined with sugar. Kombucha has trace amounts of alcohol but too little to cause intoxication or even to be noticeable. Other fermented foods, such as yogurt or fermented veggies, typically do not have any alcohol at all.

5.3. Sauerkraut

Sauerkraut is one of the oldest traditional foods, with very long roots in German, Russian and Chinese cuisine, dating back 2,000 years or more. Sauerkraut means "sour cabbage" in German, although the Germans weren't actually the first to make sauerkraut. Made from fermented green or red cabbage, sauerkraut is high in fibre, vitamin A, vitamin C, vitamin K and B vitamins. It's also a great source of iron, copper, calcium, sodium, manganese and magnesium [.15]

6. MICROBIAL SPOILAGE OF FOOD

Food spoilage is a metabolic process that causes foods to be undesirable or unacceptable for human consumption due to changes in sensory characteristics. Spoiled foods may be safe to eat, i.e., they may not cause illness because there are no pathogens or toxins present, but changes in texture, smell, taste, or appearance cause them to be rejected. Some ecologists have suggested these noxious smells are produced by microbes to repulse large animals, thereby keeping the food resource for themselves. Food loss, from farm to fork, causes considerable environmental and economic effects. Food spoilage is a broad topic that cannot be completely addressed in one review article. This paper will emphasize spoilage caused by microorganisms and will consider spoilage of foods that people purchase or consume. For example, spoilage of bread will be considered but not deterioration of wheat plants in the fields or wheat grains in storage. Non-microbial spoilage such as loss of water (shriveling of greens or carrots) or changes induced by degradative enzymes in plants (yellowing of broccoli) will not be covered. Pathogenic organisms, e.g., Listeria that cause human

illness, will not be considered even though they may also cause some spoilage.

6.1. SPOILAGE ORGANISMS

Chemical reactions that cause offensive sensory changes in foods are mediated by a variety of microbes that use food as a carbon and energy source. These organisms include prokaryotes (bacteria), single-celled organisms lacking defined nuclei and other organelles, and eukaryotes, single-celled (yeasts) and multicellular (molds) organisms with nuclei and other organelles.

Spoilage microbes are often common inhabitants of soil, water, or the intestinal tracts of animals and may be dispersed through the air and water and by the activities of small animals, particularly insects. It should be noted that with the development of new molecular typing methods, the scientific names of some spoilage organisms, particularly the bacteria, have changed in recent years and some older names are no longer in use. Many insects and small mammals also cause deterioration of food.[16]

6.2 Spoilage molds can be categorized into four main groups:

Zygomycytes are considered relatively primitive fungi but are widespread in nature, growing rapidly on simple carbon sources in soil and plant debris, and their spores are commonly present in indoor airs. Some common bread molds also are zygomycetes. Some zygomycetes are also utilized for production of fermented soy products, enzymes, and organic chemicals. The most common spoilage species are Mucor and Rhizopus. Zygomycetes are not known for producing mycotoxins but there are some reports of toxic compounds produced by a few species.

Penicillium and related genera are present in soils and plant debris from both tropical and Antarctic conditions but tend to dominate spoilage in temperate regions. They are distinguished by their reproductive structures that produce chains of conidia Penicillium spp. cause visible rots on citrus, pear, and apple fruits and cause enormous losses in these crops. They also spoil other fruits and vegetables, including cereals. Some species can attack refrigerated and processed foods such as jams and margarine. A related genus, By sochlamys, is the most important organism causing spoilage of pasteurized juices because of the high heat resistance of its spores.[17]

BACTERIA

Spore-forming bacteria are usually associated with spoilage of heat-treated foods because their spores can survive high processing temperatures. These Gram-positive bacteria may be strict anaerobes or facultative (capable of growth with or without oxygen). Some spore-formers are thermophilic, preferring growth at high temperatures (as high as 55ºC). Some anaerobic thermophiles produce hydrogen sulfide. (Desulfotomaculum) and others produce hydrogen and carbon dioxide (Thermoanaerobacterium) during growth on canned/hermetically sealed foods kept at high temperatures.

for example, soups sold in vending machines. Other thermophiles (Bacillus and Geobacillus spp.) cause a flat sour spoilage of high or low pH canned foods with little or no gas production, and one species causes ropiness in bread held at high ambient temperatures.

LACTIC ACID BACTERIA:

Lactic acid bacteria (LAB) are a group of Gram-positive bacteria, including species of Lactobacillus, Pediococcus, Leuconostoc and Oenococcus, some of which are useful in producing fermented foods such as yogurt and pickles. However, under low oxygen, low temperature, and acidic conditions, these bacteria become the predominant spoilage organisms on a variety of foods. Undesirable changes caused by LAB include greening of meat and gas formation in cheeses (blowing), pickles (bloater damage), and canned or packaged meat and vegetables. Off-flavors described as mousy, cheesy, malty, acidic, buttery or liver-like may be detected in wine, meats, milk, or juices spoiled by these bacteria. Lactic Acid Bacteria (LAB)may also produce large amounts of an exopolysaccharide that causes slime on meats and ropy spoilage in some beverages[16]

7. ASSESMENT OF MICROBIO LOGICQAL QUALITY AND SAFETY OF FOOD

Being a food product that contains perishable ingredients and involves a significant degree of manual handling during preparation, sushi is regarded as a potentially hazardous food, which may lead to foodborne disease outbreaks. the present study aimed to evaluate the microbiological quality and safety of take-away ready-to-eat sushi meals in Lisbon, Portugal. Sixty-two samples were collected from different origins (restaurant and hypermarket), and each sample was tested for aerobic mesophilic microorganisms, Enterobacteriaceae, *Escherichia coli*, positive coagulase Staphylococci, presumptive *Bacillus cereus* count, as for detection of pathogenic microorganisms, such as *Salmonella* spp., Overall, the high number of samples classified with a level of microbiological quality “unsatisfactory” and “borderline” highlights the need to review good hygiene practices, as well as

the quality of the raw materials used, to obtain a final product with a satisfactory quality and safety level. Overall, the high number of samples classified with a level of microbiological quality "unsatisfactory" and "borderline" highlights the need to review good hygiene practices, as well as the quality of the raw materials used, to obtain a final product with a satisfactory quality and safety level.[18]

7.1 SAFETY

Food-borne pathogens are one of the leading causes of illness and death particularly in developing countries. This study was aimed at analyzing the hygiene indicator microorganisms and pathogens of minced meat and contact surface materials in butcher shops in Addis Ababa, Ethiopia. Additionally, a checklist was applied to evaluate the hygiene condition of the establishments,[19]

Questionnaire/checklist was used to assess food safety knowledge of the food handlers. Meat is the major source of protein and valuable qualities of vitamins for most people in many parts of the world and is essential for the growth, repair, and maintenance of body cells and necessary for our everyday activities. However, the full value chain of meat supply from abattoirs, distribution, butchery shops to final consumers are not properly handled to ensure the microbial quality, safety, soundness. wholesomeness, and hygiene. In addition, there is no adequate information regarding the assessment of food safety practice, food-borne diseases, and microbial load on meat contact surfaces of meat-processing materials in butchery shops on a regular basis. These factors could hinder government and other stockholders to accurately apply measures on the impact of food contamination problems to public health.

8. OVERVIEW OF MICROBIOLOGICAL METHODS FOR FOOD ANALYSIS

The microbiological analysis of food is part of food safety management and conformity tests that define microbiological criteria or assess the performance of control strategies based on the Hazard Analysis and Critical Control Point. For microbiological testing of foods, rapid and conventional methods can be used. The conventional methods are called so because they were developed many years ago and have been in use ever since as the official methods of most food microbiology laboratories. These methods are described in the so-called reference publications; they are accepted internationally and recommended, for example, by the American Public Health Association, ICMSF, and the Food and Drug Administration. The limitations of the traditional methods have encouraged the development of alternative methods for microbiological analysis of foods. classical or modified culture methods and molecular methods, such as enzyme-linked immunosorbent assay (ELISA), enzyme-linked fluorescent assay (ELFA), fluorescence in situ hybridization (FISH), and conventional, real-time, and multiplex polymerase chain reaction, have been developed for detection of foodborne microorganisms. ELISA is a biochemical technique based on antibody–antigen interaction. Detection may take from 2 to 3 hr. ELFA is an automated test of the Bio-Meraux's VIDAS® system that combines immune enzymatic assay with fluorescence detection. More realistic models explicitly account for the organisms responsible for biodegradation. Fortunately, such task does not require a mandatory microbiological analysis, because microbial growth can be evaluated indirectly, from the decomposition dynamic patterns. Ideally any new source should be sampled and subjected to a full chemical analysis, including toxic substances, and a full microbiological analysis before it is put into supply. Similar checks should be carried out whenever new sources of pollution are suspected in the catchment or treatment processes are being significantly altered. Samples for microbiological analysis should be taken at least monthly from strategic locations within the distribution system, including any service reservoirs and from consumers taps.[20]

9. CONCLUSION:

Food microbiology provides compelling tools for human health and nutrition. on the other hand, unwanted spoilage of food is generally caused by microorganisms and contamination of food with pathogens causes food safety problems. When individuals are consuming various types of items, they need to ensure, they are not spoiled or rotten, and ensure they were cleaned and proper ingredients and methods need to be mode use of in their preparation. This is essential to maintain good health and the individuals are able to adequately manage food items.

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