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Food spoilage and Microorganisms

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ABSTRACT

Microorganisms can spread in extreme conditions. 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. Food spoilage is an undesirable process and is a serious problem for humans. There are many factors that accelerate and affect food spoilage. In this study, microbial behaviours in foods, microorganisms causing food spoilage and beneficial microorganisms are mentioned.

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Introduction

The deterioration of food products is one of the main problems of people. People apply many different methods to prolong the process of food spoilage and increase shelf life. It is estimated that almost half of food losses at the retail and consumer level in developed countries are lost (Burkepile et al., 2006; Amit et al., 2017).

Food spoilage;

- Physical changes (Light, temperature, mechanical damage, etc.)
- Chemical changes (Enzymatic reactions, non-enzymatic reactions, chemical interactions, etc.)
- Food decay
- Microorganism proliferation
- Other elements (Insect, animal, bird, rodent etc.)

is caused (Anwer et al., 2017; Sahu et al., 2017). Food spoilage can result in changes in color, taste and nutritional value. There are many different methods to prevent food spoilage.

These;

- Adding sugar and salt,
- Food preservatives
- Packaging
- Processes such as freezing are applied (Martorell et al., 2005; Lorenzo et al., 2018).

Microbial Behaviour in Foods

Temperature

Microorganisms according to hot areas; Psychrotrophs are divided into 3 groups: mesophiles and thermophiles. Many of the pathogens on food belong to the group of psychrotrophs. The best temperature range of psychrotrophs is 20-30°C. The development of mesophiles and thermophiles is prevented by the low temperature effect applied to the products. However, psychrotrophs can be inhibited by internal and external methods (Margesin and Schinner, 1994; Berry and Foegeding, 1997; Oliveira et al., 2015).

pH

pH is a very important parameter for the growth and development of microorganisms. Fungi can grow at lower pH compared to bacteria (Rousk et al., 2009; Jin and Kirk, 2018). Gram negatives are more sensitive to low pH than Gram positive bacteria. The growth pH range for fungi is 1.5-9.0. It is 4.0-8.5 for gram positive bacteria. Gram negative bacteria 4.5-9.0. It has the ability to grow in pH ranges (Hedrich and Schippers, 2021). Microorganisms can be grouped as follows according to their pH ranges:

- Neutrophiles optimum 5-8 pH
- Acidophiles optimum pH 5.5
- Alkaliphiles optimum pH 8.5

The growth and survival of microorganisms depend on a certain pH range. The pH change in these creatures may affect some of them negatively (Booth and Stratford, 2003).

Water Activity

Water activity is the amount of water required for biological functions that can be reduced by an osmotic effect. Water in food is made available in a variety of ways. Microorganisms need water in an available form to grow in food. The water activity of the food can be expressed as the ratio of the water vapor pressure of the food to the pure water at the same temperature. >0 to <1 because no food can have a water activity of 0 or 1 (Rahman and Labuza, 2020; Tapia et al., 2020).

Gram negative bacteria need higher water activity than Gram positive bacteria. In general, bacteria require higher water activity than fungi. Most bacteria associated with food spoilage grow above 0.91, while most filamentous fungi can grow at rates as low as 0.80 (Jay, 2000 Pujaningsih et al., 2021).

Food Microbiology

Microorganisms can be found in many different food products and can affect the quality and quantity of food. Food products are a very suitable environment for the growth of microorganisms (Mendez et al., 2020). Microorganism growths in food can cause food spoilage or decomposition. In addition, some microorganisms can cause food poisoning when they are in food products (Westerholm et al., 2020). In addition, microorganisms are used in the production of some foods. For example, microorganisms are used in the production of food products such as yoghurt, pickles and cheese (Pathak, 2020).

Microorganisms Causing Deterioration in Foods

Bacteria

The spoilage factors in heat-treated foods are especially spore-forming bacterial groups. Bacterial spores can survive even at high temperatures. Gram-positive bacteria can grow in an aerobic and anaerobic environment. They can also tend to grow in high temperatures up to 55°C (Rawat, 2015). In this context, some groups of anaerobic bacteria produce hydrogen sulphide during growth in canned/hermetically sealed foods stored at high temperatures. Bacterial groups growing at ambient temperature can cause different spoilage such as rotting of canned products, premature swelling of cheese, production of butyric acid in canned vegetables and fruits (Adams and Moss, 2000; Bintsis, 2017). Bacteria that can grow at low temperatures can produce gas and bad odors in cold meat products, pickled and dried foods. Gram-positive bacterial genera that are accepted as food pathogens worldwide are *Staphylococcus* spp., *Clostridium* spp., *Bacillus* spp. and *Listeria* spp. Gram-negative bacterial genera *Salmonella* spp, *Campylobacter* spp, *Escherichia* spp., *Shigella* spp., *Yersinia* spp., *Vibrio* spp., *Aeromonas* spp. and *Cronobacter* spp. are known as food pathogens (Allos, 1997; Adams and Moss, 2000; Jiang et al., 2004; Bintsis, 2017).

Fungi

Fungi are one of the leading factors of spoilage in food products. Fungi that reproduce by spores are an important factor in the spoilage of many foods under different conditions (Synder et al., 2019). They spread in every layer in different climates and habitats of the world. They are usefully used in the food industry as well as in the pharmaceutical industry (Hernandez and Martinez, 2018). They cause product losses by causing many damages during the harvesting, storage, packaging and processing stages of food products (Kumar and Kalita, 2017). Fungi are agents of fresh fruit and vegetable decay and are a factor in the loss of many post-harvest crops. In developing countries and tropical climatic regions, food losses due to fungi can reach up to 50 percent (Gatto et al., 2011; Shuping and Eloff, 2017; Sevindik, 2018).

Species belonging to *Botrytis* spp., *Penicillium* spp., *Fusarium* spp., *Geotrichum* spp. and *Aspergillus* spp. are the spoilage factors of many food products. In addition, mycotoxins produced by fungal species are the leading actors of many diseases. Currently, more than 400 mycoticins have been identified. Aflatoxins, Ochratoxin A, Patulin, Zearalenone, Fumonisins, Trichothecenes and Moniliformin are known mycotoxins. Mycotoxins cause various adverse effects in humans such as intestinal symptoms, allergic responses, immunosuppression, mutagenesis, inhibition of protein synthesis and cancer (Bennett and Klich 2003; Sevindik, 2018).

Protozoa

Protozoa members are diverse groups of organisms with different ecological niches. The phyla of protozoa that cause disease especially in food-borne humans are Apicomplexa, Rhizopoda, Zoomastigina, Microspora and Ciliophora. Most of them are parasitic. Protozoa, which cause disease in humans, are caused by food and beverage consumption, environmental contamination, and poor hygiene (Yoshida et al., 2011).

Viruses

Viruses are organisms with complex structures. Viruses that cause many different diseases have more than 10 families. They cause many diseases ranging from partial diarrhea to severe liver disease (Villarreal, 2004; Akhter et al., 2021). There are data available for viruses associated with foodborne gastroenteritis, also known as stomach flu, winter vomiting sickness, diarrhea and vomiting, and infectious intestinal diseases (Woolhouse et al., 2014). Enterovirus, Nipah virus, Poliovirus, Parechovirus, Tick-borne encephalitis virus are viruses that are effective on nervous tissue and nervous system (Abdullahi et al., 2020).

Viruses such as HPAI-H5N1, SARS-CoV are effective on the respiratory system. HAV, HEV has an effect on the liver. NoV, HRV, Sapovirus, Astrovirus, Adenovirus, Aichi virus cause discomfort on the intestinal system (Koopmans and Duizer, 2004; Vasickova et al., 2005; Xu et al., 2020).

Useful Microorganisms in Foods

Beneficial microorganisms in food products act in different ways. They act by growth, non-growth and by-products of microorganisms. Yogurt is obtained by the growth of microorganisms through bacteria. The prolongation of the shelf life of raw milk and meat is done by the non-growth of microorganisms. In addition, lactic acid, bacteriocins and some essential amino acids are used in foods as by-products. Consumption of microorganisms with food products such as yogurt can be beneficial for health. Examples of beneficial microorganisms found in food products are *Lactobacillus*, *Streptococcus*, *Propionibacterium*, *Saccharomyces*, *Leuconostoc* and *Aerobacter* (Schleifer, 1985; Sneath, 1986; Ray, 1992)

Conclusion

In this study, microbial behaviors in foods, microorganisms that cause spoilage in foods and beneficial microorganisms are mentioned. Microbial growth factors that can occur in food products are mentioned. In addition, beneficial and harmful microorganisms found in food products are emphasized.

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