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Microbial Spoilage of Fruit and Vegetables: Implications for Human Health

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Abstract

The majority of harvested farm produce is spoiled before consumption. About one-fourth of all farm produce is spoiled before it is available for consumption. Microbial spoilage of fruits and vegetables usually occurs during storage, transportation and during waiting for processing. It is observed that fruits and vegetables after picking and before processing are alive and can respire. The resulting respiration of the products and the normal ripening process affect the microbiological spoilage of fruits and vegetables. Microbiological spoilage of fruits and vegetables may occur in stages or forms. Knowledge of microbial invasion at these stages may help prevent bacterial contamination and product spoilage. If families become aware of the spoilage pathway of these farm products it will help to prevent consumers from getting contaminated. Generally, microorganisms on fruits and vegetables include normal flora, microorganisms from soil and water, some moulds and yeast. The deterioration of raw vegetables and fruits may result from physical factors, the action of their enzymes, and microbial action. Some of the foodborne pathogens found in contaminated fruits and vegetables are Salmonella, Campylobacter and entero-haemorrhagic *Escherichia coli*. These pathogens are responsible for most common ailments that affect millions of people annually, sometimes with severe and fatal outcomes, symptoms of which can be fever, headache, nausea, vomiting, abdominal pain and diarrhoea.

Keywords: Microbial spoilage; vegetables; fruits; health implications.

Introduction

Fruits can be referred to as structures that develop from a fertilized ovary of a flower. As the ovules become seeds, the ovary enlarges to contain them. This enlarged structure is called the fruit. Ovaries from a fertilized flower form what are called true fruits whereas ovaries arising from other structures such as calyx are called false fruits. There are

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different types of fruits because of the variation in the types of ovaries. Fruits can be separated into three major categories: simple fruits, aggregate fruits, and multiple fruits (Sukhetha, Hamilatha & Raji, 2021). Simple fruits like oranges are formed from a single ovary which may or may not consist of multiple parts, while aggregate and multiple fruits are formed from several ovaries together. Aggregate fruits like raspberries are the ripened ovaries of one flower that form a single fruit, and multiple fruits like pineapples are formed from the ovaries of separate flowers that are close together.

The main function of fruits is to produce seeds and to offer some protection to the seed. According to Slavin and Lloyd (2012), fruits may be fresh or dried. Examples of fresh fruits are mango and coconut fruits. The mango and coconut fruit are referred to as drupes, while pawpaw and tomato fruit are known as berries. Examples of dried fruits are the legumes generally such as beans, okra, and Crotollaria retusa among others. Vegetables may include all the other floral parts except the fruits, this includes the leaves and other floral parts even the stems. Nutritionally, fresh farm produce is recognized as an important source of nutrients, vitamins and fibre for humans. They play a vital role in human nutrition by supplying some necessary nutritional substances to the human daily diet that can help to maintain keep good health. They provide vital ingredients in healthy and balanced diets in the right proportion for human growth and development, when they are not spoiled (Slavin & Lloyd, 2012)

The following factors can make fruits and vegetables susceptible to spoilage, including mechanical damage resulting from the action of animals, birds or insects, or bruising, wounding, bursting, cutting or other mishandling. Previous damage by plant pathogens may also open a way for the growth of saprophytes (Oluwadara et al., 2021). Contact with spoiling fruits and vegetables may bring about the transfer of pathogens, causing spoilage and increased wastage. Improper environmental conditions during harvesting, transit, storage and marketing and the action of their enzymes may favour spoilage (Soliva-Fortuny & Martin-Belloso 2003). Susceptibility of fruits and vegetables is largely due to differential chemical components such as pH value and moisture content which greatly predispose these products to microbial spoilage.

Fruits and vegetables can be spoiled by pathogenic and non-pathogenic means. When fruits and vegetables are spoiled by pathogenic organisms, such as bacteria and fungi, this deterioration is called microbial spoilage, which is spoilage due to the activity of microbes. There are different types of microbial spoilage as a result of the organism involved (Samson et al., 2002). The most common types of spoilage are bacteria soft rot, grey mould rot, rhizopus soft rot, blue mould rot, black mould rot, downy mildew and watery soft rot. Many factors affect the spoilage of fruits and vegetables, among these is the composition of the fruit and vegetable which influences the type of spoilage, for example, bacteria soft rot is widespread among less acidic vegetables. Fungi are the most post-harvest spoilage organisms of fruits and vegetables. Fungal rots of different kinds grow on fruits and vegetables. They attack the

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fruit at all stages taking advantage of any crack or bruising (Paull & Chen, 2002).

Microorganisms that contaminate fruits and vegetables

The inner tissues of healthy plants and fruits are free from microorganisms, however, the surfaces of raw vegetables and fruits are contaminated with a variety of microorganisms and this depends on the microbial population of the environment from which the food was taken, the condition of the raw product, the method of handling, the time and conditions of storage (Beuchat, 1999).

Microbial contamination can occur during any of the production stages; in the farm, during harvest, processing, wholesale storage, transportation or retailing and handling in the home, and this contamination can arise from environmental, animal or human sources, (Jacobi *et al*., 2001). The microorganisms on the surfaces of freshly harvested fruit and vegetable include normal surface floral, those from the soil and water and some plant pathogens, others include moulds and yeast. Generally, the pathogens that are involved in the contamination of fruits and vegetables include bacteria, fungi (moulds and yeast), viruses and some protozoa (Samson & Filternbog, 2002).

Health Implications of eating contaminated fruit and vegetables.

Since most fresh produce receives minimal processing and is often eaten raw, pathogenic contamination can represent a serious health risk. Further cutting, slicing or peeling causes tissue damage which releases nutrients and facilitates the growth of microorganisms (Laura & Keith, *et al.,* 2011).

Fresh produce remains the leading cause of foodborne illness outbreaks, implicating virulent pathogens such as Shiga toxin-producing *Escherichia coli* (STEC), *Salmonella, Listeria mnoocytogenes* and human parasites (Ukuku & Saper, 2001). The open nature of the fresh produce production chain means that contamination can be introduced at various points in production; this makes them harbour a wide range of microorganisms including plant and human pathogens.

Fresh vegetables are a good source of various components of food that enhance healthy living, but evidence shows that they promote the growth of microbes which also deteriorate the food and subsequently causes adverse effect on the health of consumers (Soliva-Fortuny & Martin-Belloso, 2003).

Prevention of microbial contamination of fruits and vegetables

To reduce the risk of pathogen contamination, the FDA, 2008 released a guide to minimizing microbial food safety hazards for fresh fruits and vegetables which underlined the major reservoirs of pathogens contamination and methods required for their control (USFDA, 2008; USDH, 2011). Some of the specifications of these guidelines is Personnel cleanliness: the recommendations address two major areas: worker health and hygiene and training. FDA recommends that employees wash their hands before beginning work and after

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engaging in any activity that may contaminate their hands.

Training on sanitation principles and sanitary practices: FDA recommends that employees with cleaning and sanitation duties be trained to understand the principles and methods required for effective cleaning and sanitation, especially as those methods relate to food safety. They recommend that supervisors be trained to identify and promote good sanitary practices. FDA also recommends that employees be trained in the proper use of sanitizing agents.

Building and equipment: FDA recommends that the processing facility and its structures (such as walls, ceilings, floors, windows, doors, vents, and drains) be designed to be easy to clean and maintain and to protect the product from microbial, physical, and chemical contamination.

Environmental monitoring: FDA recommends an environmental monitoring program designed to detect areas of pathogen harborage and to verify the effectiveness of cleaning and sanitizing programs in preventing cross-contamination.

Transportation and storage: FDA recommends that finished fresh-cut products be stored and transported under conditions that will protect the food against physical, chemical, and microbiological contamination. They recommend, if feasible, that raw whole products not be stored with the finished product and that the finished product be transported in clean, sanitary vehicles (FDA, 2008; USDH, 2011).

Another effective means of control is to apply post-harvest decontamination interventions that can replace or supplement post-harvest washing. To this end, research to enhance the microbiological safety of fresh produce has started to identify and develop alternative intervention methods such as refrigeration, heat treatment, modified atmosphere packaging (MAP), and 1-methyl cyclopropane (1-MCP) and calcium chloride ($CaCl_2$) application was also vital (Fallik et al., 2001).

Washing with detergents and germicidal solutions will reduce the number of microorganisms on fruits and vegetables (Changjin et al., 2014; Fallik et al., 2001). Aseptic handling of utensils and equipment used in carrying the fruits and vegetables could help reduce the number of microbes on the products. The containers should be properly washed and sanitized from time to time; the processing equipment should also be sanitized and properly washed (Sapers & Sites 2003).

Conclusion

Fruits and vegetables are widely consumed all over the world both in raw and processed forms. They are indispensable sources of vitamins and minerals in addition to other health-promoting nutrients. However, they are subject to attack by some species of bacteria, fungi and protozoa and plants' enzymes. Various factors predispose fruits and vegetables to microbial contamination, such as the action of animals, birds or insects, bruising, wounding, bursting cutting or other forms of mishandling. Consumption of contaminated fruits and vegetable products has serious health implications for humans and could lead to mortality. Sanitary measures should therefore be taken to minimize microbial infestation of

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fruits and vegetables at personal, industrial and distribution levels.

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