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A REVIEW ON CHARACTERIZATION OF MICROORGANISM FROM FRUIT WASTE

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ABSTRACT

Fruits and vegetables are the most common horticultural crops. Due to their nutrients and health-promoting compounds, they are eaten fresh, and minimally processed. In response to the growing population and changing dietary habits, the production and processing of horticultural crops, especially fruits and vegetables, has increased dramatically. Crop, skin, rind, and pomace make up the bulk of the waste, and is high in bioactive compounds such as carotenoids, polyphenols, dietary fibres, vitamins, enzymes, and oils. Spoilage may be caused by insects, physical damage, indigenous enzyme activity within the animal or plant structure, or microbial infections. Bacteria are the microorganisms that are most commonly present in rotten fruits. They will live at appropriate temperatures with food and water, resulting in changes in the shape, colour, and smell of the fruits. An analysis of the different bacterial species found in spoiled fruits was performed.After characterization and various forms of detection techniques, several different kinds of microorganisms are discovered inside the spoiled fruits. The most common bacterial species found worldwide are *Escherichia coli* and *Bacillus* sp. in all spoiled fruits.

Keywords: Characterization, Fruit waste, Spoiled fruits, Microorganisms, Agar plate method, Nutrient agar medium

INTRODUCTION

Fruits are important in human nutrition because they provide required growth factors such as vitamins and essential minerals, which aid in living a healthy life **[1]**. Despite the fact that India is the world's fourth largest producer of fruits, losses occur in the region, during storage, transit or trans-shipment, and during handling. From the grower to the final sale, the crop goes through a series of steps. From dealer to manufacturer to customer **[2]**. They are insufficient **[3]**. Fruits provide an ideal environment for many types of microorganisms, particularly bacteria, to survive and grow. The internal tissues of the fruit contain a high concentration of carbohydrates, minerals, vitamins, and amino acids **[4]**. The majority of microorganisms present on whole fruit or vegetable surfaces are soil dwellers **[5]**. The primary cell wall of a fruit is made up of around 10% proteins and 19% polysaccharides, which are divided into three types: starch, hemicellulose, and polyose **[6]**. Pathogens can secrete a variety of cell membrane degrading enzymes in order to breach and use plant cell walls as nutrient sources, reducing post-harvest life and ultimately leading to poisonous, undesirable quality, and disease spoilage. Exo- and endo-polygalacturonases, polyose methylesterases, polyose lyases and pectate lyases, group esterases, xylanases, and endo-glucanases that cleave carbohydrate, xyloglucan, and entirely different glucans are all examples of endo-glucanases**[7, 8]**. Pectinases are the first enzymes secreted by flora pathogens as they attack plant cell walls **[9]**. Pectin-degrading enzymes weaken plant cell walls, exposing entirely different polymers to degradation by hemicellulases and cellulases. The first cell membrane degrading enzymes, which are essential virulence factors, are secreted by pathogens **[10]**.

Bacterial spoilage and microbial infection of fruit:

Spoilage is a term used to describe any alteration in the state of food that makes it unfit for human consumption **[11]**. Bacterial spoilage causes tissue softening as pectins degrade, and the entire fruit can gradually devolve into a slimy mass. Following that, starch and sugars are metabolized, resulting in undesirable odors and flavours, as well as lactic acid and ethanol **[12]**. Some spoilage microbes may colonise and cause lesions on healthy plant tissue that has not been affected **[13]**. Microbial fruit infection can occur during the growing season, processing, handling, transportation, and post-harvest storage and marketing conditions, as well as after the customer has purchased the fruit.

Fruit industry:

The waste from the agriculture industry turns out to be a huge source of natural materials. The use of this waste results in natural products with low-cost starting materials, such as antioxidants.

VIORYL SA (Athens, Greece) is an example of a Greek company that conducts research on pressed grape skins from winery waste and citrus peel after the juice has been removed. The choice of solvent(s) for efficient extraction and recycling, as environmentally friendly as possible, and selecting conditions for non-destructive product recovery are the key features of this method. A thorough review of the literature on the treatment and use of solid vegetable, fruit, and other organic waste was performed. Anaerobic digestion, animal feeding, composting, edible fibre recovery, fermentation, incineration, pyrolysis, and soil amendment were all considered as options for environmental management systems (EMS) in the report **[14]**. The factors affecting the application of heavy citrus wastewaters to the land were discussed **[15]**. Orange, grapefruit, and bergamot peels were used to extract flavonoids with pharmacological properties, such as hesperidin and naringin. **[16]**. The flavonoids were extracted from the peel using hot water and $Ca(OH)_2$. Both hesperidin and naringin yields increased as a result of peel maturity and recycling of the extracting liquor. Naringin and hesperidin yields were 15.2 g/kg and 12 g/2 kg peel, respectively **[17]**.

Fruit waste and its components:

Significant amounts of fruit waste are created by the agricultural and fruit processing industries. Banana, papaya, apple, pomegranate, pear, citrus, and grape fruit waste are some examples of fruit waste. More than 115 million tonnes of citrus fruit are produced each year worldwide, with around 30 million tonnes processed solely for juice production. As a result, approximately 15 million tonnes of citrus peel waste are produced each year. Similarly, annual production of bananas, apples, and papaya is approximately 107.1, 75.5, and 5.7 million tonnes, respectively, around the world. After processing, about 25 to 40 percent of this mass is left as waste. Fruit waste is rich in fermentable sugars like glucose, fructose, and sucrose, as well as structural cellulose and hemicellulose **[18]**. Fruit waste is an excellent source of biomass for the processing of a variety of byproducts due to its nutrient composition and abundant availability. Pectin, limonene, ethanol, and d-galacturonic acid are all present in abundance in fruit waste **[19]**. A new concept of citrus waste biorefineries has recently emerged, in which multiple chemicals are generated from citrus waste using chemical or enzymatic treatments. To

transform pectin to galacturonic acid, for example, the saccharification technique is used. Because of the particular reaction and cost-effective method, enzymatic treatment is preferable to chemical hydrolysis **[20]**. However, using fruit waste in solid state fermentation (SSF) for co production of enzymes is a promising approach for lowering the cost of enzyme development and purification.

Consumption of fruit:

Fruit consumption has increased by more than 30% in Malaysia over the last three decades as a result of increased understanding of healthy eating habits. Each year, it is estimated that about 20% of the local fruit produced is lost due to spoilage. According to data from the Department of Statistics **[21]** 18.9 billion pounds of fresh fruits is lost annually due to spoilage, accounting for 19.6% of Malaysia's edible food losses in that year.

Factors and pathogens that are affected on fruits:

One of the limiting factors that affects the fruits' life is the relatively short shelf-life span caused by pathogens. Pathogens are enumerable to decay 20-25 you look after harvested fruits in post-harvest handling even in developing countries. Owing to a lack of storage and transportation facilities, postharvest losses are typically very high in developing countries. Fungi can infect fruits at any time during the season, including during harvesting, handling, transportation, and post-harvest storage and marketing conditions, as well as after the shopper has purchased them. Fruits have a high concentration of sugars and nutrients, as well as an occasional hydrogen ion concentration, which makes them particularly attractive to fungi **[22]**. Toxic or unhealthy fungi are often referred to as spoiling fungi. In rotten fruits, poisonous fungi have been found **[23]**. When cold, some moulds may produce mycotoxins **[24]**. Unhealthy fungi, on the other hand, may cause infections or allergies. Genus spp. are known to produce a variety of toxic metabolites, such as malformins and naphthopyrans, as well as Ochratoxins (OTA), a toxic substance phytotoxin that is a very important poison worldwide due to the danger it poses to human and animal health, as a result, employees must exercise extra caution while harvesting, washing, arranging, packaging, transportation, and storage these fruits **[25]**.

Another study discovered that fruit pollution is linked to the fact that they are often eaten without being heated. The use of untreated effluent and manure as fertilisers in the fruit system can also be a major source of emissions **[26]**. In Asian countries, various fruits are sold in open markets, and the majority of them are eaten fresh, creating a perfect environment for organism contamination **[27]**. Dust-covered

pollution of domestic and commercial food is likely in developing countries like Asia, where poverty and poor sanitation are prevalent, and pathological state has been linked. Dust-covered contamination of domestic and commercial food is likely in developing countries like Asia, where poverty and poor sanitation are common, and pathological states have been related to the ingestion of faecally infected food in numerous outbreaks **[28]**. The ingestion of infected up to date fruits has been linked to several cases of human gastroenteritis **[29]**. The use of untreated waste water and manure as fertilisers for fruit processing may also pose a major pollution danger **[30]**. Acetic acid bacteria (AAB) are a bacterial taxon belonging to the Acetobacteraceae family. The aceticacid bacteria plays a crucial role in vinegare's economic growth **[31]**. AAB is found naturally in fruits and flowers, and naturally spoiled fruits are thought to be an ideal medium for the enlarging of AAB, which can lead to the partial fermentation of rotten food into alcohols **[32]**. Alcohol dehydrogenase (ADH) and compound dehydrogenase (ALDH), two membrane-bound enzymes located on the outer surface of acid bacteria's material membrane, catalyse the natural process of ethyl alcohol formation. AAB are obligate aerobes that are gram-negative, catalase-positive, oxidase-negative, non-spore forming, motile, rod-shaped, and develop in the presence of acid **[33, 34]**. Two of the most popular Acetobactaceae genera involved in food fermentation are Acetobacter and Gluconobacter. Acetobacter can convert acetate to greenhouse gas and liquid, whereas Gluconobacter cannot because it lacks the TCA cycle enzymes ketoglutareate and succinate dehydrogenases **[35]**. Unlike most acid bacteria, which are mesophilic, thermotolerant acid bacteria can thrive at temperatures as high as 42°C **[36]**.

Microbes those are responsible for fruit spoilage:

Fruits can become less palatable or even harmful to consumers as a result of spoilage.Several studies have previously confirmed the presence of bacteria such as *Pseudomonas, Erwinia, Xanthomonas, Enterobacter, lactobacillus, Bacillus, Chromobacterium, clostridium*, and *Flavobacterium* in spoiled fruits.

Penicillium expansum and *Botrytis cinerea*, two wound pathogens, can cause substantial crop loss if not thoroughly cleaned from fruits prior to storage or if fruits with infected wounds have not been thoroughly culled from the lot, as these spoilage fungi gradually weaken the wound sites, produce lesions, and cross-contaminate adjacent fruits. An expanding infestation of spoilage microorganisms may kill a significant portion of a stored lot of fruits if they receive inappropriate

preharvest fungicide application, poor washing, and inadequate culling.Pathogens of apples, pears, and other pectin-rich fruits include *P. expansum* and *B. cinerea* **[37, 38]**. B. cinerea is a particularly sophisticated and selective plant pathogen, with numerous cutinases and lipases capable of destroying pectin-rich plants.

Erwinia carotovora subsp. *carotovora* is a spoilage bacterium that causes soft rot in a wide variety of vegetables and fruits **[39]**. *E. carotovora* subsp. *carotovora* is one of several Erwinia species that invade and kill plant tissues both before and after harvest, and is the species that does the most damage to harvested vegetables.

Soft rot is a form of decay that causes watery transparency in infected leafy plant parts as well as watery disintegration of non-leafy plant materials. "Soft-rot *Erwinia*" causes infection and decay at wound sites, and once identified, can quickly lead to the product's complete destruction. Pectin lyase, polygalacturonase, pectin methylesterase, and pectate lyase are four pectin-degrading extracellular enzymes found in soft-rot *Erwinia*. Pectate lyase is the enzyme responsible for the most extensive decay of these enzymes. With four different extracellular pectate lyase isozymes, *E. carotovora* has built-in redundancy for this apparently important pathogenicity factor **[40]**.

CONCLUSION

There are various forms of bacteria that can be isolated using the isolation technique, and also obtain a pure culture of microorganisms using the isolation techniques such as serial dilution, pour plate, spread plate and streak plate. Gram staining is a technique for determining the gram nature of bacteria. This investigation into the characterization of microorganisms from spoiled fruits or fruit waste and their antimicrobial activity aids in the study of the various microorganisms found in various fruits. And, since spoiled fruits contain a variety of microorganisms, eating spoiled fruits is extremely dangerous. Often, since certain microorganisms are present on the outer layer of fruits, we cannot eat them straight from the market because certain forms are harmful to our health.

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