

Full Length Research Paper

Bacterial Contamination of Banana (*Musa acuminata*) Available in Janakpurdham Market

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Abstract

Introduction: Fruits are nutritious and flavoured plant-based foods that come from the mature ovary of a plant. Bananas are one of the most widely consumed fruits in the world. They are highly nutritious, convenient to eat, and available year-round. They are usually sweet or sour depending on the plant. Bananas are an excellent source of vitamins, minerals, fibre, and antioxidants. They are perishable food. The microorganisms get easy access to enter it. They get contaminated with different types of bacteria during harvesting, transportation, and storage. Eating of bacterial-contaminated Banana can cause health problems to people.

Materials and Methods: A total of one hundred twenty fresh banana samples were collected from different retailers of Janakpurdham metropolitan city, aseptically. Bacterial enumeration and identification were done in the microbiology lab in Model Multiple College, Janakpur, using different culture media and biochemical tests.

Results: Major isolated bacteria were *Pseudomonas species*, *Escherichia coli*, and *Staphylococcus epidermidis*. Ninety percent (108) of the samples were found contaminated with bacteria. *Staphylococcus species* were isolated from 90 (75%) samples, followed by *Escherichia coli* in 30 (40%) samples and *Pseudomonas* in 14 (11.66%).

Conclusions: Most of the collected banana samples were found to be bacterial contaminated, and the major bacteria were *Staphylococcus epidermidis* and *Escherichia coli*.

Keywords: Bacteria; Contamination; Perishable; Quality

Introduction

Banana is one of the world's most popular and widely consumed fruits. They are obtained from herbaceous flowering plants of the genus *Musa*. They are native to southern Asia but are now cultivated in tropical and subtropical regions worldwide. Bananas are known for their distinctive curved shape, smooth yellow peel after ripening, and soft-sweet flesh. Bananas are rich sources of carbohydrates, primarily in the form of natural sugars and dietary fibre. Banana is a comestible fruit botanically referred to as a berry. Banana cooking is often referred to as 'plantain'. Colour, plantain, cooking, and odour of banana largely affect the evaluation of quality by consumers compared to any other factor [1,3]. They are low in fat and protein and provide essential nutrients such as vitamin C, vitamin B6, potassium, magnesium, etc. Bananas are a staple food in many countries, particularly in Africa, Asia, and Latin America. The fruit is versatile and used in a variety of culinary applications, from snacks and desserts to savory dishes. Bananas are a significant global

export crop, with countries like Ecuador, the Philippines, and India. Bananas are not only nutritious and convenient but also integral to our diets and economies worldwide [3,5].

Banana is also a good growth medium for microorganisms, mainly bacteria and the yeast. Fruits provide the absolute conditions for many types of microorganisms to survive and grow [18].

The intramural tissues of fruits contain high concentration of different types of sugars, minerals, vitamins and amino acid [15]. The majority of microorganisms initially found on whole fruit or vegetable surfaces are residents of the soil. Spoilage refers to any alteration in the state of the food in which it is unwanted or inappropriate for human consumption [5,6]. Microbial spoilage of banana is a significant issue that affects both postharvest quality and shelf life. It is caused by microbial activities such as bacteria and yeast. Microorganisms cause visible and internal damage to the different fruits. Microbial spoilage of Banana is indicated by black or brown spots on the peel, softening of the pulp, slimy texture, off odour, moulds growth, etc. The colour of a banana could suggest the level of deterioration or spoilage. Microorganisms are a significant and major factor for Banana spoilage [16]. This microbial deterioration may occur due to high humidity, temperature, physical damage, poor post-harvest handling, delayed or inadequate refrigeration, cross cross-contamination during transportation. Bacteria like *Pseudomonas*, *Erwinia*, *E. Coli*, *Salmonella*, *Listeria*, and *Staphylococci* are mostly associated with spoilage of fruits. Major fungi that cause spoilage of Banana are *Fusarium*, *Aspergillus*, *Penicillium*, *Botryodiplodia* and *Colletotrichum* [6,7].

Microbial contamination of fruits is a common problem that occurs when microorganisms such as bacteria, yeast, and molds grow on or within [7,9]. Microbial contamination in fruits not only causes loss of quality, it can cause spoilage of food. Consumption of such spoilage fruits is the sources of food borne diseases and intoxications. Spoiled fruits are often contaminated with bacteria and fungi, which produce toxins and irritants that can inflame the lining of stomach to cause gastroenteritis. Mycotoxicosis is more harmful and cause severe intestinal problems [17]. The common bacterial contaminants are *Escherichia coli*, *Salmonella*, *Pseudomonas*, *Staphylococcus*, etc. Consumption of such affected bananas may cause nausea, vomiting, diarrhoea, abdominal pain, burning and gastroenteritis [1,4].

It is estimated that, due to spoilage, about 20% of local fruits produced are lost each year. Annually, 18.9 billion pounds of fresh fruits were lost due to spoilage, according to statistical department data. Microbial growth in bananas can cause alterations in the physical and chemical features of fruits. Microbial contamination is commonly exposed to fruits by contact with dirt, dust, water, and by handling during harvesting or post-harvesting processing [7,9].

Microbial contamination of Banana is a complex process influenced by various factors, nutrition level, water content, pH, storage condition, physical damage etc. The major food spoilage microorganisms are bacteria, yeast, and molds. Bacteria are the most common contaminants of banana [8,10].

Method

Study design and setting

This was a cross-sectional type study conducted in Janakpur Nepal, between July 2024 to the October 2024. Samples were collected from major market area such as Ramanad chowk, Zeromile, Imali bazaar, Pirari chowk and Janaki chowk of Janakpur Metropolitan city. Because these are the area where most of the fruit's retailer shops are available and also easier to collect sample.

Sample collection

One hundred twenty samples of well ripened bananas were aseptically collected in a sterile polythene bag and transported to the laboratory in insulated ice boxes to prevent contamination.

Sample preparation

The sample were taken in to the laboratory and rinsed for each with sterile distilled water, then diluted 10-fold serially. After washing the 10ml washed aqueous suspension of each sample was mixed with 90ml Nutrient broth and incubated for 24 hours at 35°C.

This overnight culture in Nutrient broth was sub cultured in to different selective media for the isolation and identification of bacteria by streak plate method.

Bacterial enumeration

The spread plate method was used on Plate count Agar to determine the number of colony forming units (CFUs).

Isolation and identification of bacteria:

As per standard protocol, various media were prepared after sterilizing plates. The serial dilution method was carried out to isolate microorganisms. An amount of diluted suspensions of banana were incubated with nutrient broth and incubated at 37°C for 24 hours. One loopful of culture from Nutrient broth were streaked on the surface of different selective media using MacConkey agar (for *E. coli*) Thiosulfate Citrate Bile sucrose agar (for *Vibrio*) Xylose Lysine Deoxycholate agar (for *Salmonella*) Manitol Salt agar (for *Staphylococcus*) Cetrimide agar (for *Pseudomonas*. Plates were incubation at 35°C for 24 to 48 hours.

Data managements and statistical analysis

Data were analysed to determine bacterial prevalence and CFU counts. Descriptive statistics were applied.

Ethical considerations

This study was conducted following ethical guidelines, ensuring no harm to individuals or the environment. No institutional review board approval was necessary as it involved non-human subjects.

Results

Out of one hundred twenty samples (120), one hundred eight (108 (90%) of the samples were found to be bacterial contaminated. Major isolated bacteria were *Pseudomonas species*, *Escherichia coli*, and *Staphylococcus epidermidis*. Twelve (12) samples (10%) were shown no growth of bacteria. *Staphylococcus species* were isolated from 81 (75%) samples followed by *Escherichia coli* in 44 (40.74%) samples and *Pseudomonas* in 14 (12.96%).

Discussions

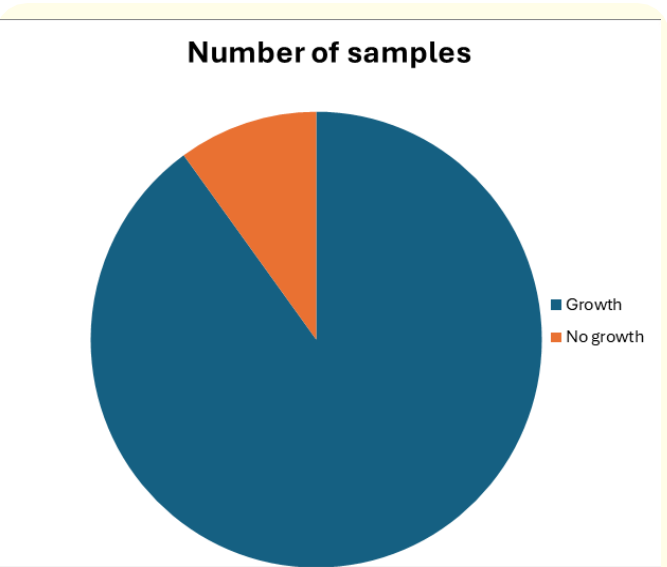


Figure 1: Bacterial contamination rate in Banana.

Table 1: Number of samples shown growth.

Growth of Bacteria	Number of samples
Growth	108(90.00%)
No growth	12(10.00%)

Table 2: Identification of isolated bacteria.

Culture Media	Colony character	Catalase	Oxidase	Indole	Coagulase	Motility	Gram reaction	Remarks
MSA	Yellow, white, smooth, spherical	Positive	Negative	Negative	Negative	Nonmotile	Positive cocci in bunch	<i>Staphylococcus epidermidis</i>
MA	Creamy white, mucoid,	Positive	Negative	Positive	Negative	Positive	Positive rod	<i>Escherichia coli</i> .
CA	Blue, green, smooth	Positive	Positive	Negative	Negative	Motile	Negative rod	<i>Pseudomonas aeruginosa</i>

Table 3: Enumeration of bacteria from the contaminated sample.

Bacteria	Number of isolates	Percentage (%).
<i>S. aureus</i>	81	75
<i>Pseudomonas aeruginosa</i>	14	12.96
<i>E. coli</i>	44	40.74

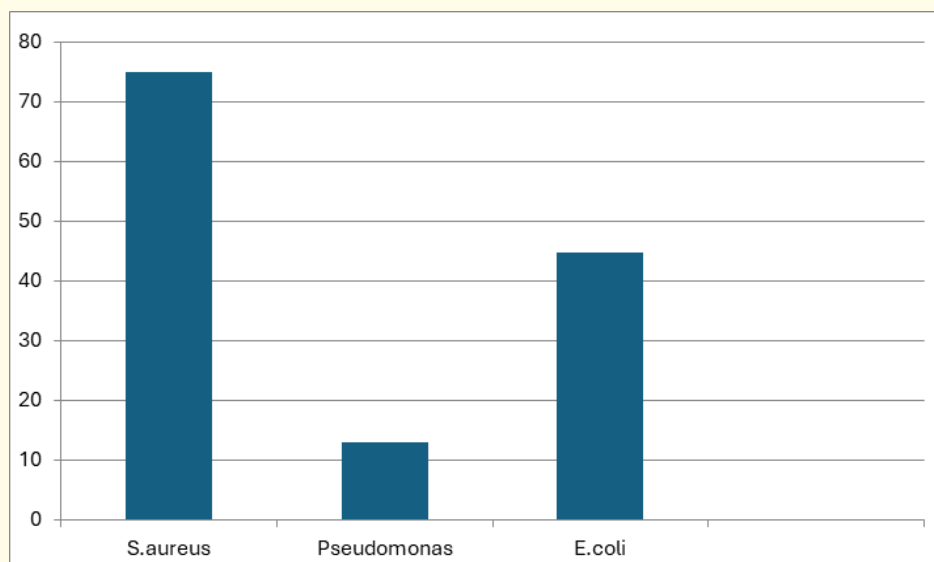


Figure 2: Graph showing types of bacteria isolated from contaminated sample.

From this Study, it was seen that the range of bacterial contamination in fruits like banana is very high. In another similar study carried out in the Janakpurdham showed bacterial count in different fruits samples were from 4.5×10^5 CFU/ml to 1.21×10^6 CFU/ml, indicating higher load of bacterial contamination. The bacteria identified in this study are also similar to the previous study. *Staphylococcus aureus*, *Streptococcus* and *Escherichia coli*. Janakpur located in terai region of Nepal is highly crowded metropolitancy. Most of the peoples are from rural area, who are the retailer of fruits. There is open drainage system in the city. People of Janakpur have poor personal hygiene and sanitation. There is scarcity of drinking water during summer [13]. People use water of ponds and ditches to rinse the fruits. Every year in summer during raining season water born disease arise as an epidemic. Janakpur is endemic zone of diarrhoea, jaundice, malaria, kala-azar and filaria. Janakpur is known as the city of pond. There are more than hundred pond in the city and all are connected with sewerage which made the water contaminated [11]. These all factors and activities associated with contamination of fruits and vegetable [14].

Banana (*Musa species*), yield an environment which suitable for the growth of organisms, this leads to its microbial spoilage. Deterioration of bananas occurs due to some bacterial species causing it to undergo undesirable changes. IMViC test was employed in identification and differentiation of microorganisms. From the biochemical results it was seen that both gram positive and gram-negative bacteria caused the spoilage of bananas. *Escherichia coli* are fecal pollution indicator of water and present in raw water. That why *E. coli* is isolated from the contaminated banana. *Staphylococcus aureus* which was isolated from most of the samples is a normal flora of nostrils, skin and hand of man. Most abundant gram-positive bacteria is *Staphylococcus aureus*, present everywhere is acts as

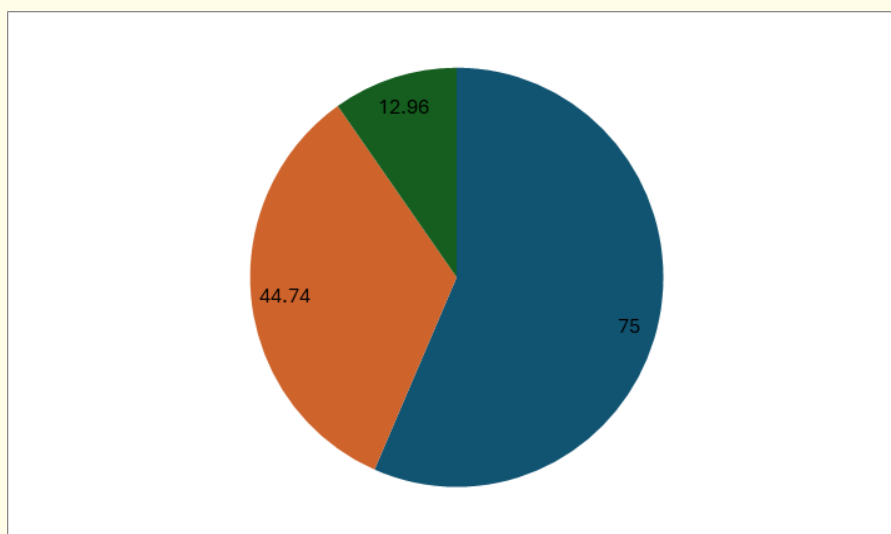


Figure 3: Percentage of Bacterial contamination.

common contaminant of food. It might be entered in the fruits from different stages of harvesting, transportation, storage and distribution. Contamination likely occurs at various points from farm to market, compounded by the use of untreated water and poor sanitation [10,12].

All the samples were found contaminated with bacteria and major contaminants was *Staphylococcus*, *Escherichia coli* and *Pseudomonas*. These bacteria bear public health concern and common pathogen in community of poor personnel hygiene condition [11]. This is the serious health concern for the people of Janakpurdham. Fruits and vegetable acquired bacteria from the different source of processing and storage. From cultivation in farm, harvesting, post harvesting, transportation and distribution fruits and vegetable become contaminated with pathogenic bacteria [10,11].

The widespread, bacterial contamination found in fresh fruits and vegetable pose a serious public health risk. The presence of *Staphylococcus*, *E. coli*, and *Pseudomonas* are linked to food borne illness- highlights the potential for community outbreak of disease like gastroenteritis. The presence of pathogenic bacteria in such common food is one of the most important methods of disease

transmission. Most of the diarrhoea and dysentery detected in our community is food born and mainly due to ingestion of such type of contaminated fruits and vegetable.

In another study, it was found that bacterial contamination is the major cause of food spoilage in Nepal. A major contributor factor of contamination is the use of untreated water and manure as fertilization in the production of fruits and vegetables [9,11]. In developing country like Nepal, both poverty and poor sanitation is commonly correlated with the food contamination. The ingestion of such types of contaminated fruits and vegetable is related to many outbreaks of human gastroenteritis.

This study reflects the poor hygienic condition of fruits and vegetables are sold in Janakpur market. Health and food security are the matters of government responsibility. It is also the responsibility of the government to ensure the right to healthy food, health and social security provided by the constitution of Nepal. Consistent monitoring and public awareness are necessary to reduce contamination risk [20].

Conclusions

This study shows that microorganism such as Bacteria causes deterioration and spoilage of banana fruits, and consumption of some of the infected banana fruits causes disease in humans.

The careless handling and storage of banana fruit, which leads to bruising or cutting on the banana peel, causes easy entry of bacteria and results in spoilage of the fruit due to the penetration and activities of microorganisms. Storing the banana in a dirty environment or the use of dirty tables and rags used in covering tables increases the incidence of contamination. The finding indicates high levels of bacterial contamination in fresh products in Janakpur, highlighting the need for improved hygiene practices. Regular testing, market monitoring, and training for vendors on safe handling practices, ensuring use of clean water in the processing of fruits, and maintaining a high level of sanitation in the storage house and during packaging should be recommended to protect consumer health. The Nepalese government should enforce the people in implement of food safety standard as per the Food Act Nepal, 2033. The Department of Food Technology and Quality Control (DFTQC) in Nepal has implemented regulations and guidelines to ensure food safety. Additionally, the government should introduce stringent penalties, including fines and imprisonment, for the production and sale of inedible products that pose a threat to human health.

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