**CHAPTER TWO**

**LITERATURE REVIEW**

## 2.1 Concept of Food Spoilage

Food spoilage refers to undesirable changes in the physical, chemical, and microbial properties of food, rendering it unsuitable for consumption. Microorganisms such as bacteria play a significant role in spoilage, leading to off-odors, discoloration, texture breakdown, and nutrient loss.

## 2.2 Importance of Ginger, Garlic, and Onion as Spices

Ginger (Zingiber officinale), garlic (Allium sativum), and onion (Allium cepa) are widely consumed for their flavor, aroma, and medicinal values. They possess antimicrobial properties but are still susceptible to microbial contamination during harvesting, handling, and storage.

## 2.3 Microorganisms Associated with the Deterioration of Spices

Microorganisms such as Bacillus, Pseudomonas, Escherichia coli, Salmonella, Shigella, and Staphylococcus aureus are commonly isolated from deteriorating spices. Their presence not only reduces quality but also poses health risks to consumers.

## 2.4 Bacterial Pathogens Commonly Associated with Food Deterioration

Several bacteria are linked to the spoilage of ginger, garlic, and onion. Each has unique characteristics and spoilage mechanisms.

## 2.4.1 Pseudomonas spp.

Pseudomonas species are Gram-negative bacteria widely associated with food spoilage. They thrive at refrigeration temperatures and produce enzymes that degrade proteins and lipids, leading to unpleasant odors and discoloration.

## 2.4.2 Bacillus spp.

Bacillus species are spore-forming Gram-positive bacteria capable of surviving harsh environmental conditions. They are common contaminants of spices and can cause spoilage through enzymatic activities.

## 2.4.3 Staphylococcus spp.

Staphylococcus aureus is a Gram-positive bacterium commonly found on human skin and in the environment. Contamination occurs through improper handling and it produces toxins that can cause food poisoning.

## 2.4.4 Enterobacteriaceae

Members of the Enterobacteriaceae family such as Escherichia coli, Salmonella, Shigella, and Klebsiella are significant spoilage and pathogenic organisms. They often contaminate spices through irrigation water, soil, and poor hygiene practices.

## 2.5 Routes of Contamination of Spices

Spices can be contaminated at multiple points: during cultivation (soil, irrigation water), harvesting (dirty tools, hands), processing, transportation, and storage. Poor hygienic practices amplify microbial load.

## 2.6 Effects of Microbial Spoilage on Human Health and Economy

Spoiled spices not only lose market value but also cause health hazards such as foodborne illnesses. Economically, microbial spoilage leads to post-harvest losses, reducing income for farmers and traders.

## 2.7 Control Measures against Microbial Spoilage of Spices

Control measures include proper sanitation, use of clean water, refrigeration, irradiation, packaging innovations, and good agricultural practices (GAP).

## 2.8 Antibiotic Resistance in Foodborne Bacteria

The misuse of antibiotics has led to the emergence of resistant bacterial strains. Foodborne bacteria isolated from spices are increasingly exhibiting resistance to common antibiotics, complicating treatment of infections.

## 2.9 Summary of Literature Review

The literature demonstrates that bacteria play a major role in the spoilage of ginger, garlic, and onion. Despite their antimicrobial compounds, these spices are vulnerable to contamination from multiple sources. Addressing spoilage requires strict hygiene practices and innovative preservation methods.

# REFERENCES

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