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Overview on Microbial Spoilage

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Abstract:- The aim of this article is to review what is microbial spoilage, it's types and preventive measures. Microbial spoilage is deterioration of food, pharmaceutical product or any other substance caused by microorganism. The main type of spoilage are pharmaceutical and food spoilage . In pharmaceutical spoilage it include solid, semisolid, liquid spoilage which become major problem to pharmaceutical industry. Microbial spoilage caused due to microorganism like bacteria, yeast, moulds of both row material and finished product. Liquid preparation are more susceptible to microbial spoilage than solid preparation. Microbial spoilage leads to change in therapeutic activity of active pharmaceutical ingrediant , colour, taste ,etc. which cause serious side effect to patient. Other measure problem is food spoilage which include meat, beer and wine, fruit and vegetable, fish, bakery spoilage. Due to spoilage there is diminishing of taste, colour, flavour and nutritive value of food which may affect the health of consumer. To avoid microbial spoilage pharmaceutical industry and food industry use various technique like use of mechanical method, chemical and natural preservatives, use of cold storage etc.

Keywords:- *Microbial Spoilage, Pharmaceutical Spoilage , Food Spoilage, Preservatives, Quality Control Of Product*.

I. INTRODUCTION

➢ *Microbial Spoilage:*

Microbial spoilage is defined as damaged to food , pharmaceuticals product that caused by microorganism such as bacteria , moulds and yeasts. Microorganism grow in all kinds of foods products , They present everywhere around us so there is always risk of microbial spoilage . [1]

➢ *Types of Microbial Spoilage :*

- *Pharmaceutical Spoilage:*

✓ *Solid spoilage*
✓ *Liquid spoilage*
✓ *Semisolid spoilage*

- *Food Spoilage:*

✓ *Meat spoilage*
✓ *Beer and wine spoilage*
✓ *Fish spoilage*
✓ *Fruit and vegetable spoilage*
✓ *Bakery product spoilage* [2]

➢ *Pharmaceutical Spoilage:*

In pharmaceutical product microbiological contamination an active or inactive ingredient used in the production of a pharmaceutical dosage form is referred to as a pharmaceutical raw material. It covers products made using any combination of the following processes: chemical synthesis, fermentation, recombinant DNA or other biotechnology techniques, extraction or recovery from natural sources. Pharmaceutical preparation may become contaminated by microbials from the raw ingredients since such microbes will inevitably make their way to the finished product. Additionally, a pharmaceutical preparation's microbial load is affected by a variety of circumstances at every stage. These include the raw materials used, the manufacturing methods or workers, the storage conditions, or the packaging materials. Most pharmaceutical raw materials, depending on their nutritional qualities and moisture concentrations, support some types of microbial development. In light of this, dry powder or tablets may experience some sort of microbial deterioration or degradation. It is generally advised to be aware of the microbial content of all drugs and medicines, whether they are needed to be sterile or not, because the most serious problem of microbial contamination of tablets occurs when there are no evident indicators of spoiling. The preservative added to the mixture to keep microbes out is another source of microbial contamination.[3]

Table 1 Contaminating Microoraganism and their Infection

Dosage form	Contaminating microbes	Infection
Tablet or capsule	Salmonella species	Salmonella infection
Eye drops	pseudomonas aeruginosa	Eye infection
antiseptic solution	pseudomonas species	Septicemia
ointments and cream	Gram negative bacteria	Dermatoses and burns
intravenous medicine	Candida species	Factor septisemia

➢ *Liquid Pharmaceutical Spoilage:*

Suspensions: As additional preservatives typically tend to be absorbed and rendered inactive by the suspended substance, microbial growth is routinely supported in aqueous suspensions of inorganic material for medicinal use. Due to the opacity of these materials, growth cannot be seen visually unless it is at the surface, as with mould contamination. When the lid is lifted, spoiling may occasionally be detected by a bad smell or flavour, but otherwise, a significant amount of bacteria may unintentionally be taken with the preparation. However, in

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addition to obvious growth, a number of other appearance alterations could be noticed, and this type of preparations can thin, separate, decolorize, or change colour.

Emulsions: O/w emulsions are especially prone to deterioration because the water in the continuous phase allow contaminants to affect the entire product. Preservatives typically only have an effect in this phase and at its edges, but the amount they produce depends on how soluble they are in the specific oil and amount of water present in the emulsion. The inactivation of preservatives by substances like nonionic emulgent may further reduce their action in addition to partition effects. These are even used by pseudomonas and have low bactericidal activity.[4]

Fig 1 Semisolid Pharmaceutical Spoilage

➢ *Preservation of Multi-Dose Medicinal Products:*

Pharmacopoeial antimicrobial effectiveness tests (AET) or preservative efficacy tests (PET) involve introducing a product to a defined number of colony forming units (CFU) of various test microorganisms (bacteria, yeasts, and fungi) at time zero, followed by the monitoring of the kill / survival rate at specified intervals up to 28 days. Gram-positive coccus (Staphylococcus aureus), Gram-negative rod (Pseudomonas aeruginosa), fungi/mold (Aspergillus niger), and yeast (Candida albicans) are among the test organisms that are advised by all pharmacopoeias.[5]

➢ *Effect of Microbial Contamination:*

Change of Activity: Pharmaceutical and cosmetic preparations that have been subjected to microbial attack may experience significant changes in the biological activity of their active components, such as a loss of activity or negative consequences brought on by the formation of toxic compounds. E.g Caffeine is frequently used as a CNS stimulant in beverages and is also used for migraine headaches when combined with ergotamine. Along with NSAID, it is a component in analgesic preparations. Theophylline (1,3-dimethylxanthine), which has greater toxicity and pharmacological effects compared to caffeine, is produced when the nitrogen source from which caffeine is derived is degraded by fungi.[6]

Food spoilage : All food goes bad. Complex organic compounds spontaneously breaking down causes some degradation. Other microbes, particularly some insects and rodents, can eat food. However, microorganisms, who effectively compete with people for scarce and expensive food resources, are the ones who degrade food intended for human consumption in the majority of cases. When given access to unprotected foods, bacteria and fungi proliferate, colonise more quickly, and produce toxic compounds.

➢ *To Help Prevent Microbe-Caused Food Spoilage, Humans use Two Main Strategies:*

- *Preventing Colonisation by Restricting Access to Foods that are Vulnerable*
- *By Creating an Unfavourable Environment, Reducing Population Size and Reducing Population Growth.*

Microbes quickly colonise unprotected foods because they are so minute, have such large populations, and frequently transmit as resistant air, water, or soil spores. Foods can be prevented from colonising by being covered or otherwise isolated, but sterile food can only be packed in an impermeable container to completely stop cantamination. In order to prevent microbial invasion, many fruits, nuts, and bird eggs are enclosed in relatively impermeable skins, shells, or waxy coatings. The reason behind canning is also this. 7

Fig 2 Food Spoilage

➢ *Meat Spoilage* :

The survival and expansion of some particular strains are determined by the favourable or unfavourable circumstances found in meat, which serves as a metaphor for a natural environment. Microorganisms require energy for metabolism, essential substances that they are unable to synthesise, and components for cell construction. All of these requirements are met by the food environment surrounding them, and their presence ensures that foodborne strains can effectively survive during the lag phase. Meat generally has a low carbohydrate content while being high in protein, fats, minerals, and vitamins; this composition allows some species to grow over others that have differing nutrient needs. After a microbial death , internal enzymes can catalyse the breakdown of particular dietary components into simpler forms that other organisms can use.[8]

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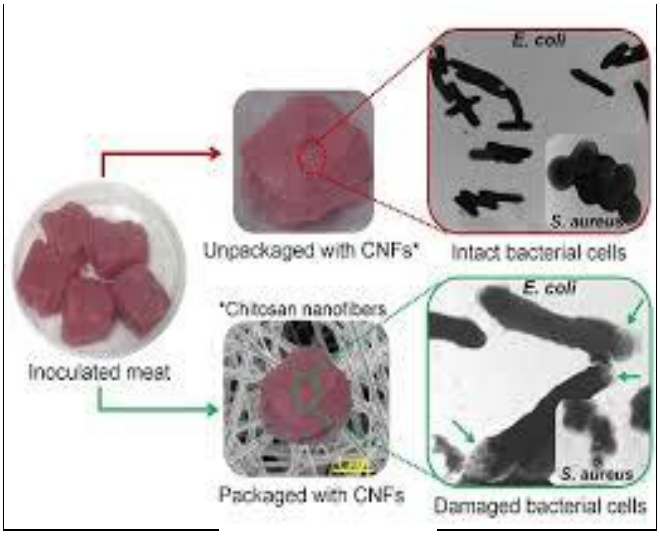

Fig 3 Meat Spoilage

➢ *Beer and Wine Spoilage:*

Microorganisms that cause beer to deteriorate are a major issue of concern for the global brewing industry. It is essential to quickly identify the presence of microorganisms and assess their capacity to produce beer to deteriorate in order to improve the hygienic state of breweries and conduct out quality control of beer products. The forcing test, which involves contaminating beer product with identified microorganisms, has been found to be the most accurate approach for determining the capacity of beer to degrade. Although this method produces results with a good degree of accuracy, it typically takes several weeks to determine whether or not microbes can cause spoilage.

According to reports, 60–70% of microbiological incidences are brought on by the lactic acid bacteria (LAB), which are recognised to be prominent beer spoiling microorganisms. This is the rationale behind the extensive study of beer spoilage LAB in brewing microbiology. One crucial characteristic of beer spoilage LAB is that not all LAB species have this ability. In actuality, only a small subset of the numerous LAB species that have been identified to far have been found to be capable of causing beer to deteriorate.[9]


Fig 4 Wine and Beer Spoilage

➢ *Preservation of Beer and Wine Spoilage :*

In general, chemical preservatives are used to prevent specific populations of bacteria that affect the final product's quality. Food preservation methods have been around for a while and include chilling, fermentation or acidification, adding chemical preservatives, and heat pasteurization and sterilization.

- *The Methods used in Wine Making to Ensure Quality and Safety from Microorganisms Involve:*

✓ *Prevent undesired microorganisms from entering the product in the first place*
✓ *Inactivate them when the first step fails*
✓ *Delay or hinder microorganism growth in the product.*[10]

➢ *Fish Spoilage:*

In addition to issues about human pathogen contamination and spread in fish and fish products, the development of some spoilage bacteria can raise issues with chemical safety. Increased histamine levels brought on by these spoilage bacteria result in scombroid toxin/histamine poisoning. Histamine can be produced by a wide variety of bacteria, including Morganella Morganii, Klebsiella pneumoniae, Hafniaalvei, Morganella psychrotolerans, Acinetobacter lwoffii, Plesiomonas shigelloides, Pseudomonas spp., Photobacterium spp., Aeromonas spp., Vibrio spp., Clo Greater efforts have been made to determine how the microbial population changes during the preservation of fish and fish products because of the vital role that the fish spoilage microbes plays in the safety of fish chemicals. In-depth knowledge on the dynamic microbial population changes during processing is being acquired thanks to the formation and use of NGS.[11]


Fig 5 Fish Spoilage

➢ *Fruit and Vegetable Spoilage:*

As biologically active sources, fruits and vegetables include phytochemicals that have antibacterial, antioxidant, antimutagenic, and anticarcinogenic properties.

Phytochemicals with antibacterial and antioxidant characteristics can be used to extend the shelf life of foods by preserving them. In addition to their antibacterial properties, phenolic compound-rich herbs and spices may

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help preserve food by lowering lipid oxidation because they are said to have strong antioxidant activity. Other than their traditional roles as natural food additives, essential oils and plant extracts are known to have multiple uses. Numerous essential oils have been shown to have anti-inflammatory, antibacterial, antifungal, and antioxidant properties. Some essential oils and the main components they contain are utilised in food systems to delay microbial deterioration. Many culinary items, dairy products, and bread goods use natural aromatic plants and spices as flavouring and seasoning agents due to their therapeutic value. Sulfur compounds, terpenes and terpene derivatives, phenols, esters, aldehydes, alcohols, and glycosides are important components of spices that have demonstrated antibacterial properties.[12]

Fig 6 Fruit and Vegetable Spoilage

➢ *Preservation of Fruit and Vegetable Spoilage :*

To control microorganisms on freshly cut produce, numerous thermal and non-thermal solutions have been developed. Hot water, heat steam, and hot sanitising solution are a few thermal processing methods that are used to treat fresh-cut vegetables. The fresh-cut produce industry has just recently adopted the technology of thermal processing. Physical or chemical processes can be used in non-thermal processing. High pressure, radiation, pulsed electric fields, pulsed white light, ultrasound, and ultraviolet radiation are examples of physical technology. Peeling, cutting, washing, and dewatering are processing methods that can affect how susceptible fresh-cut fruits and vegetables are to microbial deterioration. Natural epidermal barriers against microbial attack are removed when fresh fruit is processed by peeling, abrasion, or cutting open to reveal the interior, nutritious fruit cells. By actively introducing antimicrobial agents into the packages, these manufacturing stages actively limit microbial growth by accumulating surface moisture and exposing tissue to microbial contaminants. Appropriate cold chain temperature control is a key technology to reduce microbial deterioration.[13]

➢ *Microbial Spoilage of Bakery Products:*

The main causes frequently reducing the shelf life of bread products include microbiological deterioration. Microbial growth-related spoilage costs manufacturers and consumers money. These losses may result from a variety of specific circumstances, including product turnover, packaging, sanitary manufacturing procedures, storage environments, and storage practises. Using cluster analysis, Rachel Needham et al. (2004) examined the ability to distinguish between microbial spoilage brought on by bacteria, yeast, and fungi and enzymatic deterioration brought on by lipoxygenase after 48 hours, prior to the appearance of observable indications of decomposition. With the help of gas chromatography mass spectrometry, the volatiles released by the various types of bread spoilage and unspoiled bread analogues were determined. The amounts of each microorganism used rose over time, according to microbial analyses. Although their growth is more constrained by low water activity and low pH, bacteria can nonetheless contaminate baked goods. Bacillus subtilis spores are a good example of heat-resistant organisms; after 20 minutes at 65°C, 55% of them are still active in amylase. This microbe generates rope in bread and is found in raw components like flour, sugar, and yeast. Ropey bread has a crumb that is exceptionally moist and stringy, discolouring from brown to black, and emitting a rotten fruit stench.[14]

Fig 7 Bakery Product Spoilage

➢ *Prevention of Microbial Spoilage:*

Classification of preservatives:

- *Class I (natural preservatives): E.g.: Salt, sugar, vinegar, syrup, spices, honey and edible oil.*
- *Class II (chemical or synthetic preservatives): E.g.: Benzoates, sorbates, nitrites and nitrates of sodium or potassium, sulfites, glutamates and glycerides.*

Preservatives can be classified as antimicrobial, antioxidant, or antienzymatic, whether they are natural or synthetic. Antimicrobials inhibit the growth of bacteria, yeast, and moulds or prevent it. The breakdown of fats and oils in food that occurs in the presence of oxygen and causes rancidity is slowed or prevented by antioxidants. The majority of oral, dental, cutaneous, nasal, parenteral, vaccination, rectal, and ophthalmic products all contain preservative.[15]

- *Preservative Efficacy Test (PET) Methodology:*

The PhEur microbiological challenge test method was used to evaluate the preservative effectiveness in oral formulations. A final concentration of about 106 CFU.g1 was achieved by separately inoculating the formulations (samples of 20 g) with bacterial and fungus suspensions in sterile containers. To ensure a uniform distribution of microorganisms, the mixtures were thoroughly mixed before being incubated at 20 to 25 °C. Samples (1.0 g) were withdrawn after contact times of 0, 7, 14, 21, and 28 days and put into 99.0 mL of neutralising medium MLEB (Difco). Colony forming units (CFUs) were counted after a 3- and 5-day incubation at 37°C and 30°C for bacteria and fungi, respectively. Cell viability was assessed using the pour-plate count method in TSA or SDA plates. Each count was carried out twice. Each organism had a growth control at day 0 using just the medium, ensuring that the formulations included an acceptable and consistent amount of live bacteria. In addition, days 7 and 21 were added, even though they are not PhEur assessment points, to enable a weekly data analysis.[16]

- *Quality Assurance (QA) and Microbiological Quality Control (QC) Of Pharmaceutical Products:*

QA involves formulation development, research and development (R&D), GMP, quality control (QC), and resolving customer complaints. The estimation of the microbial burden in the manufacturing environment, on equipment, on workers, in bulk materials, during process checks, and in completed products before they are released onto the market are all included in the quality control of pharmaceutical products. The initial stage of microbiological control during production is the assessment of the raw materials and water used in production. The in-process monitoring of a pharmaceutical product indicates whether the product quality has been maintained up to the recommended specifications during manufacturing and processing. The finished product tests, based on microbiological, biochemical, serological and molecular techniques, demonstrate whether the release specifications have been met appropriately.[17]

II. CONCLUSION

All the pharmaceutical product and food material must be free from microbial spoilage , so we need to maintain the quality of product. To prevent microbial spoilage pharmaceutical and food industries implement various technique like use of natural and chemical preservatives, use of mechanical method like sun drying, cold storage of row material etc. The main motive of preservation is to avoid contact of microorganism to food and pharmaceutical product and its row material. Microbial spoilage of product have direct effect on health of consumer , so we need to avoid microbial spoilage while retaining the quality of product.

REFERENCES

[1]. https://www.google.com/search?q=microbial+spoilage+&ei=6LZDY8D4M9ix3LUP5bOwqAQ&ved=0ahUKEwjAjOrt_9T6AhXYGLcAHeUZDEUQ4dUDCA4&uact=5&oq=microbial+spoilage+&gs_lcp=Cgdnd3Mtd2l6EAMyBQgAEIAEMgUIABCABDIFCAAQgAQyBQgAEIAEMgUIABCABDIFCAAQgAQyBQgAEIAEMgUIABCABDIFCAAQgAQyBQgAEIAEOgoIABBHENYEELADOgYIABAeEBY6BQgAEIYDOggIABAeEA8QFjoHCAAQgAQQDToHCC4QgAQQDToFCC4QgARKBAhBGABKBAhGGABQxC5Y9Ehg_lNoAXABeACAAaQBiAHODJIBBDAuMTKYAQCgAQHIAQjAAQE&sclient=gws-wiz

[2]. Dr.Chandrakant Kokare, Pharmaceutical Microbiology Principles And Application, Nirali Prakashan,2015,14.1-14.5

[3]. Oday husham kamil, dumitru lupuliasa,modern aspects regarding the microbial spoilage of pharmaceutical products ,farmacia, 2011,59(2),134

[4]. R. smart and d. f. spooner, Microbiological spoilage in pharmaceuticals and cosmetics,journal of the society of cosmetic chemisis,1972,23, 721-73

[5]. MostafaEssamEissa,Application of Dose-Response Model of Infection in The Risk Assessment for Contamination Health-Hazard from Pharmaceutical Dosage Forms ,2016,9,5-6

[6]. Huy Dao, Prit Lakhani, Anitha Police, VenkataramanKallakunta,SankarSrinivasAjjarapu, Kai-Wei Wu,PranavPonkshe, Michael A. Repka, and S. NarasimhaMurthy,Microbial Stability of Pharmaceutical and Cosmetic Products, American Association of Pharmaceutical Scientists,2017

[7]. Sean T. Hammond, James H. Brown, Joseph R. Burger, Tatiana P. Flanagan, Trevor S. Fristoe, Norman Mercado-Silva, Jeffrey C. Nekola, Jordan G. Okie,Food Spoilage, Storage, and Transport: Implications for a Sustainable Future,2015,65(8),758-759

[8]. Maria F. Iulietto, Paola Sechi, Elena Borgogni&Beniamino T. Cenci-Goga,Meat Spoilage: A Critical Review of a Neglected Alteration Due to Ropy Slime Producing Bacteria,Italian Journal of Animal Science, 2015,14:3,317

[9]. Koji Suzuki1,5, Kazumaru Iijima1, Kanta Sakamoto2, Manabu Sami3 and Hiroshi Yamashita4 ,A Review of Hop Resistance in Beer Spoilage Lactic Acid Bacteria ,2006,112(2), 173

[10]. M. du Toit and LS. Pretorius, Microbial Spoilage and Preservation of Wine: Using Weapons from Nature's Own Arsenal -A Review,2000,21,74

[11]. Lina Sheng LuxinWang, The microbial safety of fish and fish products: Recent advances in understanding its significance, contamination sources, and control strategies,*Compr Rev Food Sci Food Saf*, 2021,20,754

[12]. Mohammad Ali Sahari, Sara Asgari ,Effects of Plants Bioactive Compounds on Foods Microbial Spoilage and Lipid Oxidation ,Food Science and Technology,2013, 1(3),52

[13]. P. Saranraj, D. Stella and D. Reetha , microbial spoilage of vegetables and its control measures: a review ,International Journal of Natural Product Science 2012, 2(2),9-10
[14]. P.Saranraj and M.Geetha, Microbial Spoilage of Bakery Products and Its Control by Preservatives,International Journal of Pharmaceutical & Biological Archives 2012; 3(1), 40
[15]. PV Kamala Kumari, S Akhila, Y Srinivasa Rao and B. Rama Devi, ,A multifaceted Review journal in the field of Pharmacy,A multifaceted Review journal in the field of Pharmacy,. 2019;10(1),99
[16]. B. De Spiegeleer, E. Wattyn, and G. Slegers,P. Van der Meeren,K. Vlaminck,L. Van Vooren,The Importance of the Cosolvent Propylene Glycol on the Antimicrobial Preservative Efficacy of a Pharmaceutical Formulation by DOE-Ruggedness Testing,Pharmaceutical Development and Technology, 2006,11,277
[17]. Rashed Noor*, Nagma Zerin, Kamal Kanta Das,Microbiological quality of pharmaceutical products in Bangladesh: current research perspective,Asian Pacific Journal of Tropical Disease,*2015; 5(4),265-266*