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<u>Microorganisms and Food Spoilage</u>

Spoiled Food

1. Damage or injuries that make food undesirable for human consumption.
2. Can be the result of:
    a. insect damage
    b. physical injury
    c. enzymatic degradation
    d. microbial activity

Basic Types of Food Spoilage

1. Appearance: when a food "looks bad," what is this referring to?
    a. Microbial growth
        mycelia or colonies visible on surface
        development of cloudiness in liquids
    b. Changes in food color due to heme or chlorophyll breakdown
        colony pigments, growth of mycelia, etc.

2. Textural changes (feel)
    a. Slime formation
        due primarily to surface accumulation of microbial cells
        also be a manifestation of tissue degradation
    b. Tissue softening due to enzymatic degradation (e.g. soft rot in veggies)

3. Changes in taste and odor
    a. Development of:
        1. nitrogenous compounds (ammonia, amines, etc.)
        2. sulfides
        3. organic acids

The **numbers** and **types** of MO in a food are largely determined by:

1. Environment from which the food was obtained.
2. Microbiological quality of the food in its raw or unprocessed state (intrinsic factors).
3. Handling and processing sanitation.
4. Effectiveness of packaging, handling and storage conditions in restricting microbial growth (extrinsic factors).

Specific Food Groups

A. **Fresh Meats:**
   Chemical composition:
      -75% water
      -18% protein
      -3% fat, 1% ash, traces of CHO, vitamins, etc.

1. Whole Meats:
   The microflora of fresh meat is composed primarily of:

1. Gram negative aerobic rods such as *Pseudomonas, Acinetobacter* and *Moraxella.*
2. *Bacillus* and clostridia (e.g. *C. perfringens*) are also common on all types of meat.

Although subsurface portions of meat are generally sterile, some parts such as lymph nodes may be heavily contaminated.
Mechanical disruption of the tissue during processing can distribute microorganisms from the meat surface throughout the product.

Fresh meats are among the most perishable foods.

Storage temperature is the single most important control factor for meat spoilage.

Handout - Sources of Contamination

Several genera of **molds** grow on the surface of meat and can cause spoilage, but cannot grow on meat stored below 5^{o}C.

Usually, fresh cut meats in the refrigerator at high humidity undergo bacterial spoilage by:

Gram negative aerobes like *Pseudomonas, Acinetobacter* and *Moraxella* spp.

The intrinsic and extrinsic parameters of ground beef favor these bacteria so strongly that they are almost exclusive spoilage agents.

Meat spoilage is characterized by the appearance of off odors and slime, which are manifest when surface loads exceed **10^7 CFU/cm^2**.

The slime is due to the accumulation of bacterial cells.

Interestingly, meat spoilage (including poultry and fish) occurs without any significant breakdown of the primary protein structure.
Instead, spoilage bacteria utilize glucose, free amino acids or other simple nitrogenous compounds to attain population of about **10^8 CFU/cm^2**, at which point the organoleptic quality of the meat will clearly reveal it is spoiled.

2. Ground Meats:

Same MO as whole meats, but always have higher microbial loads.

- greater surface area which gives microbes better access to the food and also traps air to favor the growth of gram-negative, aerobic bacteria like *Pseudomonas* spp.
- every handling or processing (storage utensils, cutting knives, grinders) step can contribute additional contamination to the final product.
- one heavily contaminated piece (e.g. a lymph node) can contaminate an entire lot when they are ground together.

Use of: (a) soy protein extenders (b) mechanically deboned meat (MDM)

-does not change the microflora significantly but does raise the pH of meat which leads to more rapid spoilage

-ground beef pH=5.1-6.2, add extenders raise it to 6.0-7.0)

3. **Vacuum packaged meats**
   - 80% of beef leaves packing plant in vacuum package.
   - not all O_2 is removed during packaging but residual is consumed by respiration of aerobic MO and the tissue itself
   - results in increased CO_2 levels and thus get a longer shelf life.

Impermeable films used:
1. CO_2 levels are higher
2. Eh lower

The microflora shifts from predominantly G- aerobes to G+ anaerobes and microaerophilic lactic acid bacteria (LAB) like *Lactobacillus*, *Carnobacterium* and *Leuconostoc.*

- if nitrites have been added to the vacuum packaged meat (e.g. to inhibit *C. botulinum* in hams, bacon), LAB domination is even more pronounced

In general, vacuum packaged meats are considered very safe foods and free from most pathogenic species of bacteria.

-with the possible exception of *S. aureus* and *Y. enterocolitica*

Spoilage in vacuum packaged meats is manifest by:

1. Slime development
2. **Greening** caused by microbial production H_2O_2 or H_2S.
   H_2O_2 production in meat has been associated with several types of lactic acid bacteria (primarily *Lactobacillus*)

Handout - Meat Pigments

The oxidant (H_2O_2) reacts with nitrosohemochrome (cured meat color cmpd) to form a green porphyrin compound.

H_2S greening occurs in fresh meats that have been vacuum packaged and stored between 1-5^{o}C. H_2S reacts with myoglobin to form sulphmyoglobin in meats with a pH above 6.0.
H_2S is produced by:
1. *Shewanella putrefaciens* and *Pseudomonas* spp. (when O_2- permeable films are used).
2. Some lactobacilli (when O_2- impermeable films are used).

Off odors which result from:
1. the release of short chain fatty acids
2. the production of volatile compounds like acetoin, diacetyl and H_2S (and many other compounds, depending on the dominant spoilage bacterium)

The type of spoilage bacteria that will dominate is influenced by several factors that include:

1. Is the meat product raw or cooked?
   Cooked products have a higher pH (>6.0) which may allow growth of G- facultative anaerobic pathogens like *Yersinia enterocolitica*.

Raw products have a pH of about 5.6 which favors lactic acid bacteria, esp. *Lactobacillus, Carnobacterium,* and *Leuconostoc.*

2. Nitrite concentration in meat.
   High nitrite conc. favors lactic acid bacteria.
   Low nitrite levels may allow growth of *Brochothrix thermosphacta* (G+ rod, fac anaer, growth @ 0-30^{o}C from pH 5.0-9.0 catalase+).

   B. thermosphacta is an important spoilage bacterium in anaerobically stored meats kept at low temperature, but the bacterium is inhibited by nitrite.

4. Processed meats (hot dogs, sausage and luncheon meats)

These products are composed of a variety of blended ingredients, any of which can contribute microorganisms to the food.

Yeasts and bacteria are the most common causes of spoilage, which is usually manifest in **3 ways**:

A. **Slimy spoilage**
   Like other meat products, this occurs on the surface and is caused by the buildup of cells of yeasts, lactobacilli, enterococci or *Brochothrix thermosphacta.*
   Washing the slime off with hot water can restore the product quality.

B. **Sour spoilage.**
   Results from growth of lactic acid bacteria (which originate from contaminated ingredients like milk solids) under the casing.

   These organisms ferment lactose and other CHOs in the product and produce organic acids.
   Taste is adversely affected but the product is not harmful if eaten.

C. **Greening** due to H_2O_2 or H_2S production.
   Because greening indicates more extensive product breakdown, I would not recommend eating green wieners.

Reasons Cured meats (bacon, hams) are resistant to spoilage:

1. Use of nitrite/nitrate
2. Smoking or brining of hams
3. The high fat content (thus low a_w) of bacon

Instead, spoilage of these products is often caused by molds from several genera including *Aspergillus, Fusarium, Mucor, Penicillium, Rhizopus* and *Botrytis.*

5. Poultry:

a. general trends are the same as other fresh meats
b. similar microflora on fresh birds
c. whole birds have lower counts than cut-up parts
d. additional processing steps add to the microbial load

When poultry is in the advanced stages of spoilage, the skin will often fluoresce under UV because so many fluorescent pseudomonads are present.

Off odors generally appear before sliminess develops.
The same bacteria can produce visceral taint, a condition manifest by off odors in the abdominal cavity or poultry.

Point to remember:
During the initial stages of spoilage, the skin supports bacterial growth better than does the tissue (which remains essentially free of bacteria for some time). Thus, the skin can sometimes be removed to salvage the food.

6. Fish:

a. Fish have high nitrogen content but no carbohydrate.
b. The microbial quality of fish and especially shellfish is heavily influenced by the **quality of the water** from which they were harvested.

Unsanitized processing steps are principal culprits in fish products with high microbial loads.
In general, frozen fish products have lower counts than fresh products.

Bacteria on fresh fish are concentrated on the outer slime, gills and intestine.

Spoilage of salt- and freshwater fish occurs in similar ways; the most susceptible part of the fish to spoilage is the gill region, and the best way to detect spoilage in fresh fish is to sniff this area for off odors produced by *Pseudomonas and Acinetobacter-Moraxella* bacteria.
The odors include ammonia, triethylamine, H_2S and other compounds.

If fish are not eviscerated quickly, bacteria will move through the intestinal walls and invade the meat that lies next to the abdominal cavity.

Spoilage of **crustaceans** (shrimp, lobsters, crabs and crayfish) is similar, but these products have some CHO (0.5%) and more free amino acids so spoilage can occur more rapidly.

Microflora of mollusks can vary a great deal depending on the quality of the water from which they were harvested.
Shellfish are filter feeders and can be expected to contain almost any microorganism or virus that occurs in the water where they were obtained.

If these products were taken from clean waters, then the usual *Pseudomonas* and *Acinetobacter-Moraxella* types of spoilage bacteria dominate.

B. Vegetables

Typical composition:
-88% water
-8.6 % CHO. Includes readily available mono- and disaccharides like glucose and maltose, as well as more complex oligosaccharides, which are available to fewer types of microorganisms.
-1.9% protein
-0.3 % fat
-0.84 % minerals

-also contain fat and water soluble vitamins and nucleic acids ($<1\%$).
-pH of most veggies is around 6.0; within the growth range of many bacteria

Vegetables are a good substrate for yeasts, molds or bacteria

It is estimated that 20% of all harvested fruits and vegetables for humans are lost to spoilage by these microorganisms.

Because bacteria grow more rapidly, they usually out-compete fungi for readily available substrates in vegetables. As a result, bacteria are of greater consequence in the spoilage of vegetables with intrinsic properties that support bacterial growth (favorable pH, Eh).

Microflora of vegetables is primarily composed of:

1. G+ bacteria like lactic acid bacteria (e.g. leuconostocs, lactobacilli, streptococci.
2. Coryneforms and staphylococci (the latter coming from the hands of employees during processing.
3. Staphylococci are usually unable to proliferate but cross-contamination can introduce them into other foods where growth conditions are more favorable.

Soft rot

a. One of the most common types of bacterial spoilage.
b. caused by *Erwinia carotovora* and sometimes by *Pseudomonas* spp., which grow at 4^oC

Softening can also be caused by endogenous enzymes.

FlavrSavr story:

a. polygalacturonase (PB); hydrolyzes a (1-4) glycosidic bond in pectin which leads to softening.
b. Calgene made antisense RNA to tomato pg, constructs soften slower and so can be harvested after they are ripe (better flavor).
c. First commercially avail. genetically engineered vegetable.

Mold spoilage

a. In vegetables where bacterial growth is not favored (e.g. low pH), molds are the principal spoilage agents.
b. Most molds must invade plant tissue through a surface wound such as a bruise or crack.
c. Spores are frequently deposited at these sites by insects like *Drosophila melanogaster*, the common fruit fly.
d. Other molds like *Botrytis cinerea*, which causes grey mole rot on a variety of vegetables, are able to penetrate fruit or vegetable skin on their own.

The microflora of vegetables will reflect:

a. the sanitation of processing steps
b. the condition of the original raw product

Soil-borne MO such as clostridia are common on raw vegetables, and some species, like *C. botulinum*, are of such great concern that they are the focus of processing steps designed to destroy MO.

Sources of Contamination

1. Surface contamination – Soil, water, air, human pathogens from manure (night soil)
2. Harvesting - hand picking vs. machines
   high damage if crop is ripe...harvest before ripe
   Geotrichium candidum – mold on harvestors
3. Packaging: containers reused-sanitized
4. Processing plant
5. Markets – handling, cross-contamination

C. Fruits

Average composition
- -85% water
- -13% CHO
- -0.9% protein (a bit low on nitrogen sources)
- -0.5% fat
- -0.5% ash
- -trace amounts of vitamins, nucleotides, etc.
- -less water and more CHO than veggies
- -low pH (1.8-5.6)

Handout - Fig. 7.1 Type pH of vegetables and fruits

Like vegetables, fruits are nutrient rich substrates but the pH of fruits does not favor bacterial growth. As a result, **yeasts and molds are more important than bacteria** in the spoilage of fruits.

a. Several genera of yeasts can be found on fruit.
b. Because these organisms grow faster than molds, yeast often initiate fruit spoilage.
c. then molds finish the job by degrading complex polysaccharides in cell walls and rinds.

Specific Spoilage Organisms:

1. Blue rot – *Penicillium*, fruits
2. Downy mildews – *Phytophora*, large masses of mycellium (grapes)
3. Black rot – *Aspergillus*, onions
4. Sour rot – *Geotrichum candidum*

Eggs

Eggs have several intrinsic parameters which help to protect the nutrient-rich yolk from microbial attack. These include the shell and associated membranes, as well as lysozyme, conalbumin, and a high pH (>9.0) in the white. Freshly laid eggs are generally sterile, but soon become contaminated with numerous genera of bacteria.

Eventually, these MO will penetrate the eggshell and spoilage will occur.
Pseudomonads are common spoilage agents, but molds like *Penicillium* and *Cladosporium* sometimes grow in the air sac and spoil the egg.

Cereal and Bakery Goods

These products are characterized by a low a_w which, when stored properly under low humidity, restricts all MO except molds. *Rhizopus stolonifer* is the common bread mold, and other species from this genus spoil cereals and other baked goods.

-Refrigerated frozen dough products have more water and can be spoiled by lactic acid bacteria.

Fermented Foods and Beverages

The low pH or ethanol content of these products does not allow growth of pathogens, but spoilage can occur.

Beer and wine (pH 4-5) can be spoiled by yeasts and bacteria. Bacteria involved are primarily lactic acid bacteria like lactobacilli and *Pediococcus* spp., and (under aerobic conditions) acetic acid bacteria like *Acetobacter* and *Gluconobacter* spp. Acetic acid bacteria convert ethanol to acetic acid in the presence of oxygen.

The anaerobic bacterium *Megasphaera cerevisiae* can also spoil beer by producing isovaleric acid and H_2S.

Spoilage in packaged **beer** is often due to growth of the yeast *Saccharomyces diastaticus,* which grows on **dextrins** that brewers yeast cannot utilize. *Candida valida* is the most important spoilage yeast in wine. In either case, spoilage by yeasts results in the development of turbidity, off flavors and odors.

Wines can also be spoiled by lactic acid bacteria which are able to convert malic acid to lactic acid (**malo-lactic fermentation**). This reduces the acidity of the wine and adversely affect wine flavor. In some areas (e.g. Northwest), wine grapes have too much malic acid so this fermentation is deliberately used to reduce the acidity of grape juice that will be used for wine.

Yeasts, molds and lactic acid bacteria can also spoil fermented vegetables such as sauerkraut and pickles, as well as other acid foods like salad dressings and mayonnaise. Spoilage in fermented vegetables is often manifest by off odors or changes in the color (chromogenic colony growth) or texture (softening) of the product. In mayonnaise or salad dressing, the first signs of spoilage are usually off odors and emulsion separation.

Elementary techniques used in Food preservation

Food preservation involves preventing the growth of bacteria, fungi (such as yeasts), or other micro-organisms (although some methods work by introducing benign bacteria or fungi to the food), as well as slowing the oxidation of fats that cause rancidity. Food preservation may also include processes that inhibit visual deterioration, such as the enzymatic browning reaction in apples after they are cut during food preparation.

Many processes designed to preserve food will involve a number of food preservation methods. Preserving fruit by turning it into jam, for example, involves boiling (to reduce the fruit's moisture content and to kill bacteria, etc.), sugaring (to prevent their re-growth) and sealing within an airtight jar (to prevent recontamination). Some traditional methods of preserving food have been shown to have a lower energy input and carbon footprint, when compared to modern methods.

Some methods of food preservation are known to create carcinogens. In 2015, the International Agency for Research on Cancer of the World Health Organization classified processed meat, i.e. meat that has undergone salting, curing, fermenting, and smoking, as "carcinogenic to humans".

Maintaining or creating nutritional value, texture and flavor is an important aspect of food preservation, although, historically, some methods drastically altered the character of the food being preserved. In many cases these changes have come to be seen as desirable qualities – cheese, yogurt and pickled onions being common examples.

Drying:-

is one of the oldest techniques used to hamper the decomposition of food products. As early as 12,000 B.C., Middle Drying Eastern and Oriental cultures were drying foods using the power of the sun. Vegetables and fruits are naturally dried by the sun and wind, but "still houses" were built in areas that did not have enough sunlight to dry things. A fire would be built inside the building to provide the heat to dry the various fruits, vegetables, and herbs.

Cooling:-

Cooling preserves food by slowing down the growth and reproduction of micro-organisms and the action of enzymes that cause food to rot. The introduction of commercial and domestic refrigerators drastically improved the diets of many in the Western world by allowing foods such as fresh fruit, salads and dairy products to be stored safely for longer periods, particularly during warm weather.

Freezing:-

Freezing is also one of the most commonly used processes, both commercially and domestically, for preserving a very wide range of foods, including prepared foods that would not have required freezing in their unprepared state. For example, potato waffles are stored in the freezer, but potatoes themselves require only a cool dark place to ensure many months' storage. Cold stores provide large-volume, long-term storage for strategic food stocks held in case of national emergency in many countries.

Boiling:-

Boiling liquid food items can kill any existing microbes. Milk and water are often boiled to kill any harmful microbes that may be present in them.

Heating:-

Heating to temperatures which are sufficient to kill microorganisms inside the food is a method used with perpetual stews. Milk is also boiled before storing to kill many microorganisms.

Salting:-

Salting or curing draws moisture from a substance through a process of osmosis. substances are cured with salt or sugar, or a combination of the two. Nitrates and nitrites are also often used to cure meat and contribute the characteristic pink colour. It was a main method of preservation in medieval times and around the 1700s.

Pickling:-

Pickling is a method of preserving food in an edible anti-microbial liquid. Pickling can be broadly classified into two categories: chemical pickling and fermentation pickling.

In chemical pickling, the food is placed in an edible liquid that inhibits or kills bacteria and other micro-organisms. Typical pickling agents include brine (high in salt), vinegar, alcohol, and vegetable oil, especially olive oil but also many other oils. Many chemical pickling processes also involve heating or boiling so that the food being preserved becomes saturated with the pickling agent. Common chemically pickled foods include cucumbers, peppers, corned beef, herring, and eggs, as well as mixed vegetables such as piccalilli.

Canning:-

Canning involves cooking food, sealing it in sterile cans or jars, and boiling the containers to kill or weaken any remaining bacteria as a form of sterilization. It was invented by the French confectioner Nicolas Appert.By 1806, this process was used by the French Navy to preserve meat, fruit, vegetables, and even milk. Although Appert had discovered a new way of preservation, it wasn't understood until 1864 when Louis Pasteur found the relationship between microorganisms, food spoilage, and illness.

Foods have varying degrees of natural protection against spoilage and may require that the final step occur in a pressure cooker. High-acid fruits like strawberries require no preservatives to can and only a short boiling cycle, whereas marginal vegetables such as carrotsrequire longer boiling and addition of other acidic elements. Low-acid foods, such as vegetables and meats, require pressure canning. Food preserved by canning or bottling is at immediate risk of spoilage once the can or bottle has been opened.

Jellying:-

Food may be preserved by cooking in a material that solidifies to form a gel. Such materials include gelatin, agar, maize flour, and arrowroot flour. Some foods naturally form a protein gel when cooked, such as eels and elvers, and sipunculid worms, which are a delicacy in Xiamen, in the Fujian province of the People's Republic of China. Jellied eels are a delicacy in the East End of London, where they are eaten with mashed potatoes. Potted meats in aspic (a gel made from gelatine and clarified meat broth) were a common way of serving meat off-cuts in the UK until the 1950s. Many jugged meats are also jellied.

Jugging:-

Meat can be preserved by jugging. Jugging is the process of stewing the meat (commonly game or fish) in a covered earthenware jug or casserole. The animal to be jugged is usually cut into pieces, placed into a tightly-sealed jug with brine or gravy, and stewed. Red wine and/or the animal's own blood is sometimes added to the cooking liquid. Jugging was a popular method of preserving meat up until the middle of the 20th century.

Industrial/modern techniques

Pasteurization:-

Pasteurization is a process for preservation of liquid food. It was originally applied to combat the souring of young local wines. Today, the process is mainly applied to dairy products. In this method, milk is heated at about 70 °C for 15 to 30 seconds to kill the bacteria present in it and cooling it quickly to 10 °C to prevent the remaining bacteria from growing. The milk is then stored in sterilized bottles or pouches in cold places. This method was invented by Louis Pasteur, a French chemist, in 1862.

Vacuum packing:-

Vacuum-packing stores food in a vacuum environment, usually in an air-tight bag or bottle. The vacuum environment strips bacteria of oxygen needed for survival. Vacuum-packing is commonly used for storing nuts to reduce loss of flavor from oxidization. A major drawback to vacuum packaging, at the consumer level, is that vacuum sealing can deform contents and rob certain foods, such as cheese, of its flavor.

Artificial food additives:-

Preservative food additives can be *antimicrobial*, which inhibit the growth of bacteria or fungi, including mold, or *antioxidant*, such as oxygen absorbers, which inhibit the oxidationof food constituents. Common antimicrobial preservatives include calcium propionate, sodium nitrate, sodium nitrite, sulfites (sulfur dioxide, sodium bisulfite, potassium hydrogen sulfite, etc.) and disodium EDTA. Antioxidants include BHA and BHT. Other preservatives include formaldehyde (usually in solution).

Irradiation:-

Irradiation of food is the exposure of food to ionizing radiation. The two types of ionizing radiation used are beta particles (high-energy electrons) and gamma rays (emitted from radioactive sources as cobalt-60 or cesium-137). Treatment effects include killing bacteria, molds, and insect pests, reducing the ripening and spoiling of fruits, and at higher doses inducing sterility. The technology may be compared to pasteurization; it is sometimes called "cold pasteurization", as the product is not heated.

The irradiation process is not directly related to nuclear energy, but does use radioactive isotopes produced in nuclear reactors. Cobalt-60, for example does not occur naturally and can only be produced through neutron bombardment of cobalt-59. Ionizing radiation at high energy levels is hazardous to life (hence its usefulness in sterilisation); for this reason, irradiation facilities have a heavily shielded irradiation room where the process takes place. Radiation safety procedures are used to ensure that neither the workers in such facilities nor the environment receives any radiation dose above administrative limits.

Pulsed electric field electroporation:-

Pulsed electric field (PEF) electroporation is a method for processing cells by means of brief pulses of a strong electric field. PEF holds potential as a type of low-temperature alternative pasteurization process for sterilizing food products. In PEF processing, a substance is placed between two electrodes, then the pulsed electric field is applied. The electric field enlarges the pores of the cell membranes, which kills the cells and releases their contents. PEF for food processing is a developing technology still being researched. There have been limited industrial applications of PEF processing for the pasteurization of fruit juices.

High-pressure food preservation

High-pressure food preservation or pascalization refers to the use of a food preservation technique that makes use of high pressure. "Pressed inside a vessel exerting 70,000 pounds per square inch (480 MPa) or more, food can be processed so that it retains its fresh appearance, flavor, texture and nutrients while disabling harmful microorganisms and slowing spoilage." By 2005, the process was being used for products ranging from orange juice to guacamole to deli meats and widely sold.

Biopreservation:-

Biopreservation is the use of natural or controlled microbiota or antimicrobials as a way of preserving food and extending its shelf life. Beneficial bacteria or the fermentation products produced by these bacteria are used in biopreservation to control spoilage and render pathogens inactive in food. It is a benign ecological approach which is gaining increasing attention

Probiotics in food:-

Probiotics are beneficial forms of gut bacteria that help stimulate the natural digestive juices and enzymes that keep our digestive organs functioning properly. In addition to taking a probiotic supplement, you can also eat probiotic foods that are a host to these live bacterium.

The strongest evidence to date finds that probiotic benefits include:

- Boosting immune system.
- Prevent and treat urinary tract infections.
- Improve digestive function.
- Heal inflammatory bowel conditions like IBS. .
- Manage and prevent eczema in children.
- fight food-borne illnesses

1. Yogurt

One of the best probiotic foods is live-cultured yogurt, especially handmade. Look for brands made from goat's milk that have been infused with extra forms of probiotics like lactobacillus or acidophilus. Goat's milk and cheese are particularly high in probiotics like thermophillus, bifudus, bulgaricus and acidophilus. Be sure to read the ingredients list, as not all yogurt is made equally. Many popular brands are filled with high fructose corn syrup, artificial sweeteners and artificial flavors and are way too close to being a nutritional equivalent of sugary, fatty ice cream.

2. **Probiotic Milk Products and Digestive Health**

Probiotic products consist of specific strains of live bacteria that have potentially favourable health effects. A number of studies provide evidence that milk products with probiotics may be beneficial for digestive health and may improve various digestive problems.

Highlights

- Fermented dairy products with active bacterial cultures are one of the most common sources of probiotics;
- Probiotic milk products may be beneficial in alleviating symptoms for a number of gastrointestinal conditions, including *Helicobacter pylori* infection, irritable bowel syndrome and antibiotic-associated diarrhea;
- Milk products with probiotics may improve gut microbiota, have an immunomodulatory effect, and thus maintain overall health.

Probiotics are defined as "live microorganisms which, when administered in adequate amounts, confer a health benefit on the host."[1] This term refers to specific strains of bacteria, and typical probiotics include lactic acid bacteria such as *Lactobacillus*and *Bifidobacterium*. These strains are widely used in the fermentation of dairy products, such as yogurt, cheese and kefir. Fermented dairy products with active bacterial cultures are therefore one of the most common sources of probiotics. These types of probiotic-containing milk products may be beneficial for a number of gastrointestinal and digestive conditions.

The Evidence

***Helicobacter pylori* Infection**

A 2009 systematic review and meta-analysis of randomized controlled trials evaluated the effect of fermented milk products enriched with probiotics on *Helicobacter pylori* infection. A total of 10 eligible studies, which included 963 adults and children, were assessed. It was found that fermented milk-based probiotic preparations reduce *Helicobacter pylori* infection rates by approximately 5% to 15%.

A prospective study published in 2012 examined the effect of probiotic-containing yogurt on systemic immunological response among 38 children with *Helicobacter pylori* infection. The study concluded that intestinal microbiota balance can be maintained and humoral and cellular immunity can be stimulated in children who regularly consume yogurt.

Irritable Bowel Syndrome
A review of 42 trials systematically examined the role of lactic acid bacteria, such as lactobacilli, bifidobacteria, enterococci, streptococci and bacilli, on irritable bowel syndrome. A majority of the clinical trials reviewed showed that lactic acid bacteria alleviate abdominal pain and discomfort. Both single- and multi-centre studies have shown that lactic acid bacteria may improve abdominal bloating and distension. Out of 24 trials, improvements in bowel habit satisfaction were found in 13 studies, and 16 trials reported improvements in symptom severity.

Another multi-centre, double-blind, randomized controlled trial, also published in 2013, was conducted in England to evaluate the effect of a probiotic versus non-probiotic yogurt in irritable bowel syndrome with constipation. The study consisted of 179 adults who were randomized to consume one of these two products twice daily over 12 weeks. Significant improvements were observed for both groups but there was no difference between groups.

Inflammatory Bowel Disease
Probiotics could have beneficial effects on inflammatory bowel disease, but the evidence is limited. According to a systematic review and meta-analysis, the effects could differ depending on disease subtype and probiotic strain. In addition, findings from a cohort study of middle-aged women living in France indicate that milk products are a protein source that does not increase the risk of inflammatory bowel disease.

Antibiotic-Associated Diarrhea
Evidence demonstrates that probiotics are associated with reduced antibiotic-associated diarrhea. In a meta-analysis of 82 randomized controlled trials, a statistically significant association was found between the administration of probiotics and the reduction of antibiotic-associated diarrhea. Various studies included in the meta-analysis consisted of interventions with probiotic milk products, which showed that probiotic milk products may be efficacious in preventing antibiotic-associated diarrhea.

Constipation
A 2013 meta-analysis of randomized controlled trials indicated that short-term probiotic supplementation reduces intestinal transit time. Greater effects were observed among adults who were older or constipated. Certain probiotic strains, such as strains of *Bifidobacterium lactis*, appear to be more efficacious.

Lactose Intolerance
In an evidence-based report on lactose intolerance and health published in 2010, a systematic review of the literature indicated that there was insufficient evidence to determine the effectiveness of yogurt and probiotics in alleviating the symptoms of lactose intolerance. However, many people who have difficulty digesting milk find that they can digest yogurt. This is because beneficial bacteria in yogurt have lactase activity and thus help in lactose digestion.

Gastric Cancer
It has been postulated that probiotics may help in gastric cancer prevention, but the evidence so far is mainly based on experimental in-vitro data. For instance, a study was conducted on fermented milk containing *Propionibacterium freudenreichii* as microbiota, and it was demonstrated that this probiotic fermented milk had pro-apoptotic effects on human gastric cancer cells.

Probiotic ice-cream:-

The belief that **ice-creams** are unhealthy conflicts with the belief that **probiotic ice-cream** is healthy. The belief that healthy products are not tasty conflicts with the belief that **probiotic ice-cream** is tasty. The belief that bacteria are harmful conflicts with the belief that **probiotic ice-cream** contains bacteria.