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microbiological spoilage of Canned food

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بسم الله الرحمن الرحيم
قل سيروا في الأرض فانظروا كيف بدأ الخلق ثم الله ينشئ النشأة الآخرة
إن الله علي كل شئ قدير
سورة العنكبوت آية :20

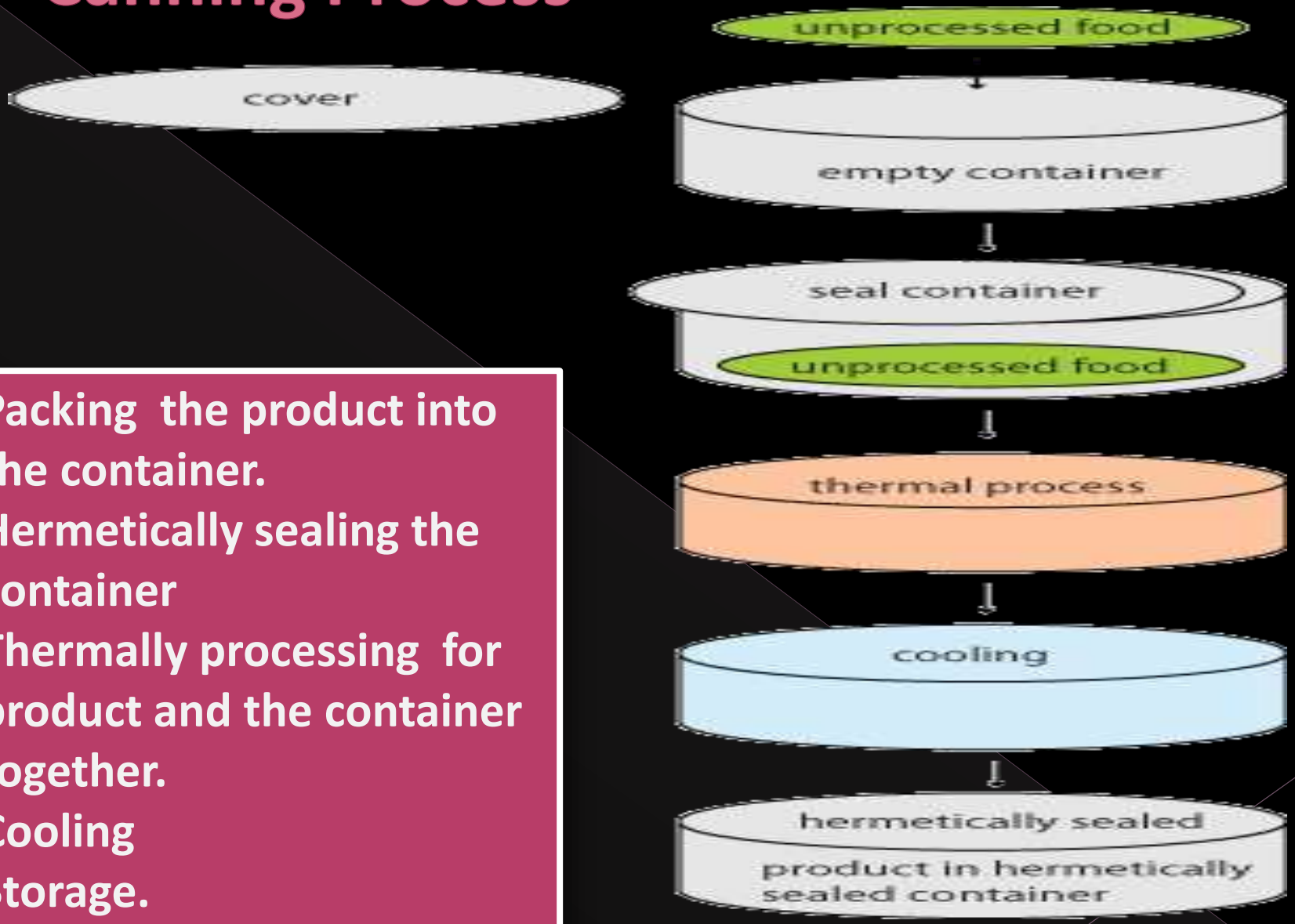
Canning

- **Canning is** a method of preserving food in which the food contents are processed and sealed in an airtight container.
- Canning provides shelf life typically ranging from one to five years, although under specific circumstances it can be much longer A freeze-dried canned product, such as canned dried lentils, , could last as long as 30 years in an edible state

Discovary

- The canning process dates back to the late 18th century in France when the Emperor Napoleon Bonaparte, concerned about keeping his armies fed,
- offered a cash prize to whoever could develop a method of food preservation.
- Nicholas Appert conceived the idea of preserving food in bottles, like wine.
- After 15 years of experimentation, he realized if food is sufficiently heated and sealed in an airtight container, it will not spoil. No preservatives are necessary.

Canning Process



1. Packing the product into the container.
2. Hermetically sealing the container
3. Thermally processing for product and the container together.
4. Cooling
5. Storage.

The main steps in canning are:

1. **Packing the product** into the container.
2. **Hermetically sealing the container.** Hermetically sealed container means a container that is designed and intended to be secure against the entry of microorganisms.
   - **Sealing glass jars**
   - **Sealing metal cans**
3. **Thermally processing** the product and the container together.

- **High-Acid foods**(jams, jellies, sauerkraut, kimchi, pickles, fermented vegetables,) are processed at **100° C** in **Water bath canner**
- **Low-Acid foods**(such as meat, poultry, fish and vegetable) must be processed **at 121° C** in **Pressure canner**

High-Acid foods

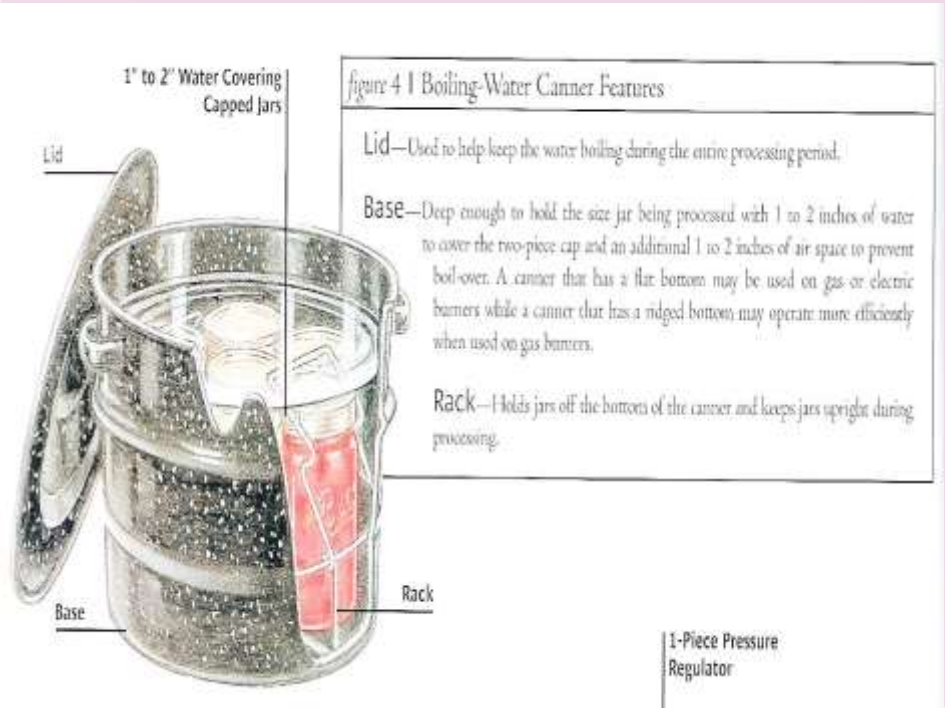
- fruits,jams, jellies, sauerkraut,fermented vegetables,lemon juice.
- 100° C in water bath canner
- A boiling water bath can only heat the food to the temperature of boiling water. Because the acidity of the ingredients as much as the heat of the processing that

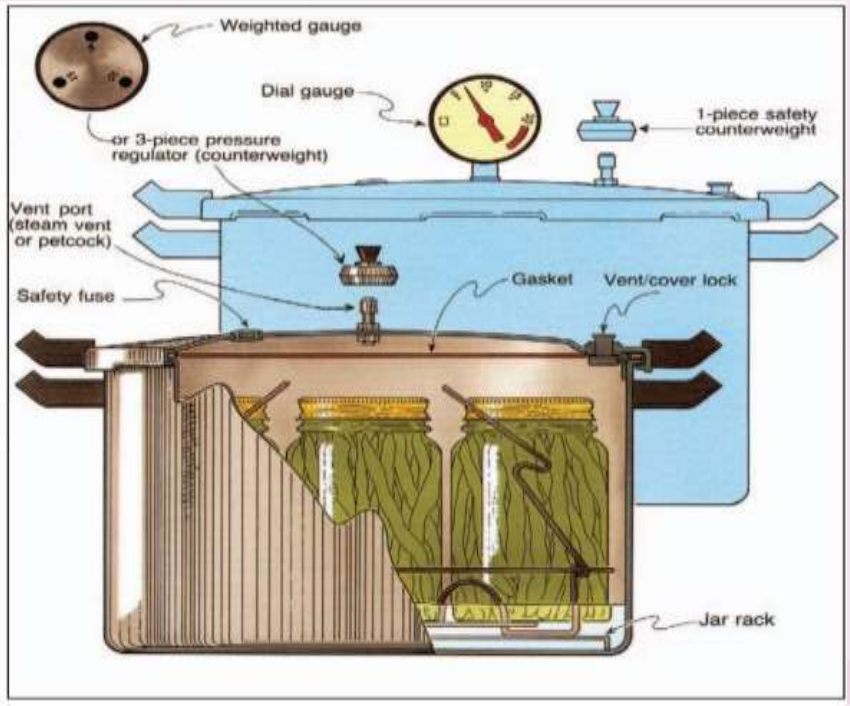
safely preserves the food.

VS

Low-Acid and alkaline foods

- such as meat, fish and vegetable
- 116 - 121° C in pressure canner
- heating the food in the jars to hotter than the temperature of boiling water. The reason for that is that although botulism bacteria is killed at the temperature of boiling water, botulism spores can survive that temperature. The spores can be eliminated by temperatures hotter than boiling water.





4. Cooling

cans is immersed in cold water Or let them to cool at room temperature from 12-24 hours.

- As the temperature of the product drops, a vacuum forms inside and pulls down the lid. This is often accompanied by a popping sound and happens within minutes after removing the jar from the water bath canner.

5. **Storage:** Should be stored in a cool , dry, dark place, Should not be stored where temperature extremes exist, Should be used within one year for best quality

SPOILAGE OF CANNED FOODS

- **The spoilage of can could be due to biological or chemical reasons or combination of both. The biological spoilage is primarily due to microbial growth. while chemical spoilage is due to hydrogen produced due to reaction of acid in food and iron on can.**
- **The degree of swelling can also be increased by high summer temperature.**

Soilage of canned food

Chemical soilage

- Hydrogen swell
- Sulphiding
- Rust&damage

Biological soilage

- incipient
- leakage spoilage
- inadequate thermal
- Growth of thermophilic microorganisms
- Growth of acid-tolerant spore forming microorganisms

1. Chemical spoilage

1.1. Hydrogen swell

- The chemical spoilage in most cases is due to production of hydrogen gas produced in can

because of action of acid of food on iron of can

- Occur mainly in acidic foods (canned fruits). Not related to fermentation or bacterial spoilage.
- Can show varying degree of bulging when opened odorless burnable gas ..
- . It occurs due

a) Increased storage temperature.

b) Increased acidity of food

c) Presence of soluble sulfur and phosphorous compounds

d) lacquering of can at internal

surfaces

1.2 Sulphiding (Sulphur stinker spoilage):

- this spoilage cause discoloration of inside of can with pink to dark purple.
- Due to hydrogen sulfide formation as a result of breakdown of sulphur-containing proteins (liver, kidney, tongue) by organisms of *colestidia* groub (*Cl. nigrificans* (sulphur stinker)) with the odor of rotted egg.
- It may be accompanied with blackening when H_2S react with steel base of tin forming iron sulphide and may lead to pitting.

1.3- Rust and damage:

Rust is reddish brown ferric oxide seen under label.

- Slight rust:pass for rapid consumption.
- Severe rust:condemned and rejected.

2.Biological spoilage

incipient spoilage

leakage spoilage

inadequate thermal processing

Thermophilic Spoilage

due to storage at high temperatures

Growth of acid-tolerant spore forming microorganisms

(1) Incipient Spoilage (Spoilage Before Processing)

- If food is held too long during or between filling and closing the containers and the delivery of the thermal process .
- The microorganisms normally may have sufficient time to replicate and spoil the product.
- This microorganisms that grow will be subsequently killed by the thermal process however,if sufficient growth occurred to alter the product characteristics ,the product would be considere dspoiled.

(2) Post-process Contamination (Leakage Spoilage)

- **occur when there is an opportunity for microorganisms to enter the container.**
- **maintaining the hermetic seal is essential to preventing leakage spoilage.**
- Leakage is generally due to inadequately formed seams, defective containers or closures, cooling water contaminated with large numbers of microorganisms, container damage, rough handling of processed containers, dirty can-handling equipment, or a combination of these

(3) Inadequate Thermal Processing

- Heat processes for canned foods are designed to destroy all microorganisms of public health significance as well as microorganisms of non-public health.
- "Inadequate thermal processing" indicates that the thermal process that was applied to the product was insufficient to destroy these organisms.
- An inadequate thermal process may occur for a number of reasons:

(1) The thermal process is not properly established.

(2) The time and/or temperature specified in the thermal process for the product and specified container size is not used.

(3) some mechanical or personnel failure.

- this spoilage usually appearing as swollen containers.
- This spoilage caused by a single sporeforming type of organism.

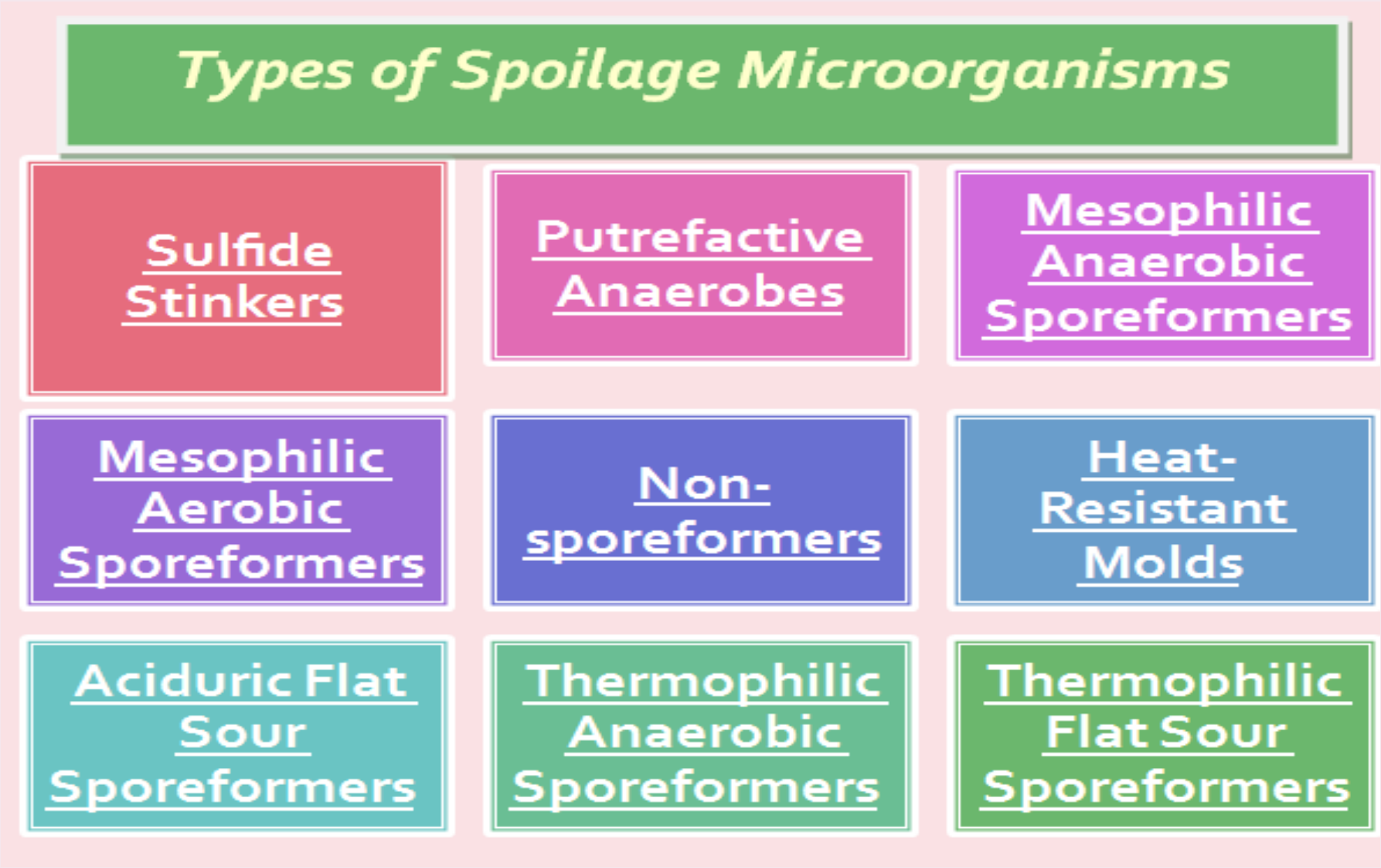
(4) Thermophilic Spoilage

- The spores of thermophilic bacteria usually have a greater heat resistance than the spores of mesophilic bacteria. Therefore, heat processes designed to kill mesophilic bacterial spores are not adequate to destroy thermophilic bacterial spores.
- it would be impractical to establish thermal processes to destroy these organisms because the quality of the food products would suffer greatly.
- Therefore, 1. products must be properly cooled after thermal processing, 2.and held below 35◦C during subsequent storage, in order to prevent thermophilic spoilage.
- Thermophilic spoilage has economic significance, but not public health significance, since there are no known thermophilic foodborne pathogens.

(5)Growth of Acid-Tolerant SporeForming Microorganisms

- occur in product with a pH less than or equal to 4.6.
- Butyric acid anaerobes can be a problem in products with a pH between 4.2 and 4.6.
- Heat-resistant molds have caused spoilage problems in acid and acidified foods

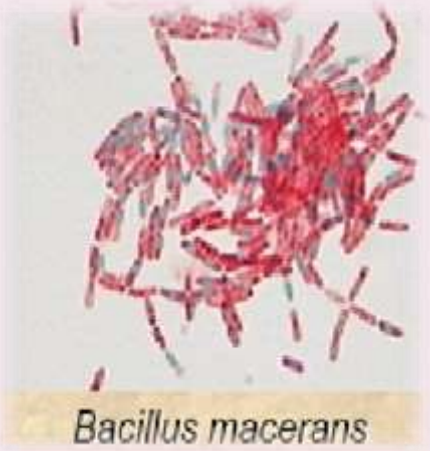
Types of Spoilage Microorganisms



(1) Mesophilic Aerobic Sporeformers:

- Strains of Bacillus
- The presence of Bacillus species is generally the result of improper process application.
- Moderate heat resistance .


Bacillus subtilis


Bacillus macerans

(2) Mesophilic Anaerobic Sporeformers:

- primarily belong to the genus *Clostridium*, and those of greatest interest in foods
- fall into two main groups : *C. sporogenes (*the proteolytic strains of *C. botulinum).. Clostridium perfringens*(the nonproteolytic strains) .


Clostridium butyricum


Clostridium sporogenes

(3) Putrefactive Anaerobes:

- Proteolytic mesophilic anaerobes may cause spoilage of canned foods having a pH of 4.8 or above
- Spoilage by these anaerobes is generally characterized by gas production that swells the container,are reduced product pH,and a foul putrid odor,hence the generic name "putrefactive anaerobes" .

(4) Aciduric Flat Sour Sporeformers

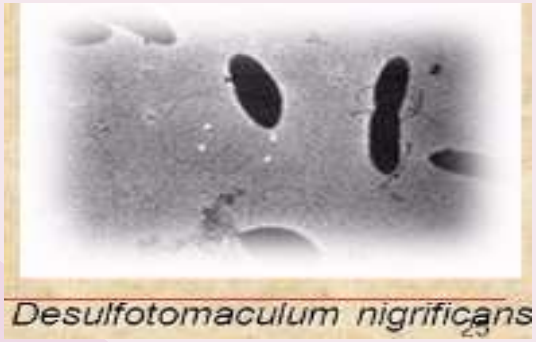
- facultative anaerobic sporeformers that produce gas in spoiled products.
- The ends of spoiled cans remain flat
- the term "flat sour." Spoiled products have an off-flavor that has been described as "medicinal" or "phenolic."
- These organisms (e.g., Bacillus coagulans) have caused spoilage in acid foods such as tomato products


Bacillus coagulans

(5) Thermophilic Flat Sour Sporeformers:

- The organisms in this spoilage family generally grow between 40 and 90◦C, with optimum growth seen between 55 and 65◦C.
- The spores of these organisms have a very high heat resistance than the thermal processes However it do not produce toxins or infections in humans..
- The most common species of concern are *Bacillus stearothermophilus.*

(6) Thermophilic Anaerobic Sporeformers


Desulfotomaculum nigrificans

Sulfide "Stinkers

- *Desulfotomaculum nigrificans* (known as *Clostridium nigrificans*) Is a thermophilic anaerobe
- produces hydrogen sulfide with its characteristic rotten egg odor and discoloration

- seen as a problem in the sugar industry, spoiling molasses on occasion.
- The interior of the can and the product blackens from the interaction of the dissolved H2S with the iron in the container

(7) Heat-Resistant Molds

- Most fungi have very limited heat resistance, except for a group of fungi.
- Acidic and suger concentration as high as 70% can permit mold growth
- The most isolated are from the genera *Byssochlamys, Neosartorya, and Talaromyces*
- isolated mainly from fruit and fruit products such as fruit juices

(8) Non-sporeformers:

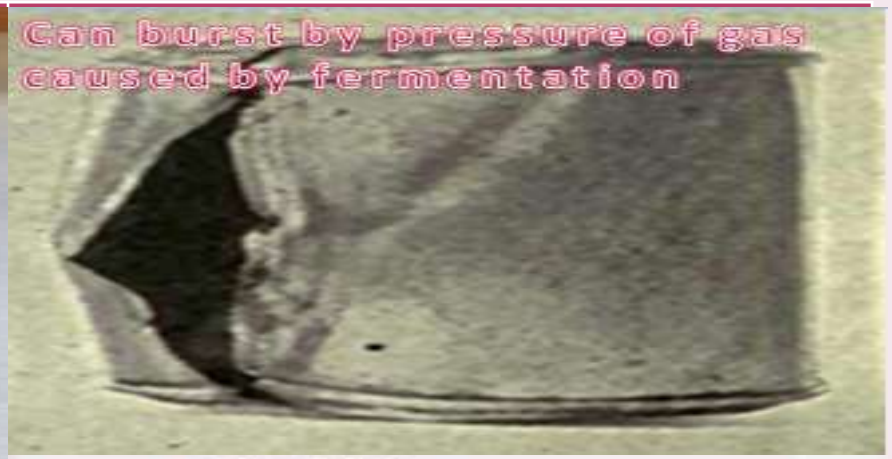
- isolated in the examination of spoiled canned foods.
- When these oranisms are present, they indicate the product was not processed or that post-process contamination occurred.
- more common in underprocessed acid and acidified foods where the thermal process is much less severe than for low-acid foods.
- They include yeast, mold, Gram-positive bacteria such and Gram-negative bacteria such as Enterobacter and Pseudomonas.

Signs of Spoilage in Canned Food

- Can has swollen irregular appearance: Most microorganisms produce gas when they grow. If they grow in a canned food, the gas produced generally cannot escape and causes the container to swell , providing visible evidence that the product inside might be spoiled.
- if sufficient gas is produced, they may explode from excessive internal pressure. Flexible or non-rigid containers will appear “ballooned.”
- Can is leaky or corroded.
- Can is rusty
- Contents smell putrid or alcoholic
- Contents are discoloured
- Syrup looks turbid, cloudy, slimy or mouldy.


Syrup looks turbid


Swollen can

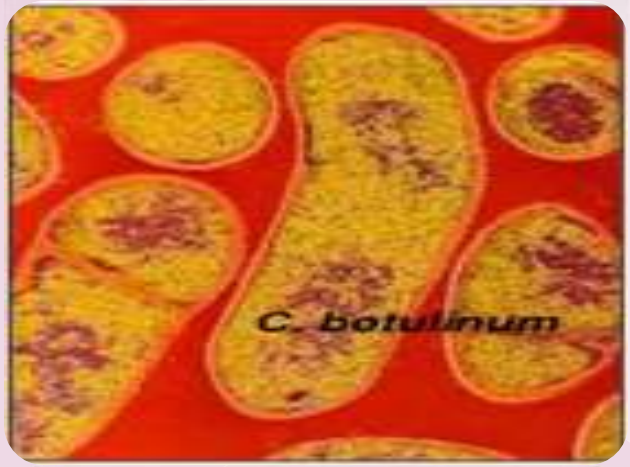

Can burst by pressure of gas caused by fermentation


Leaky can

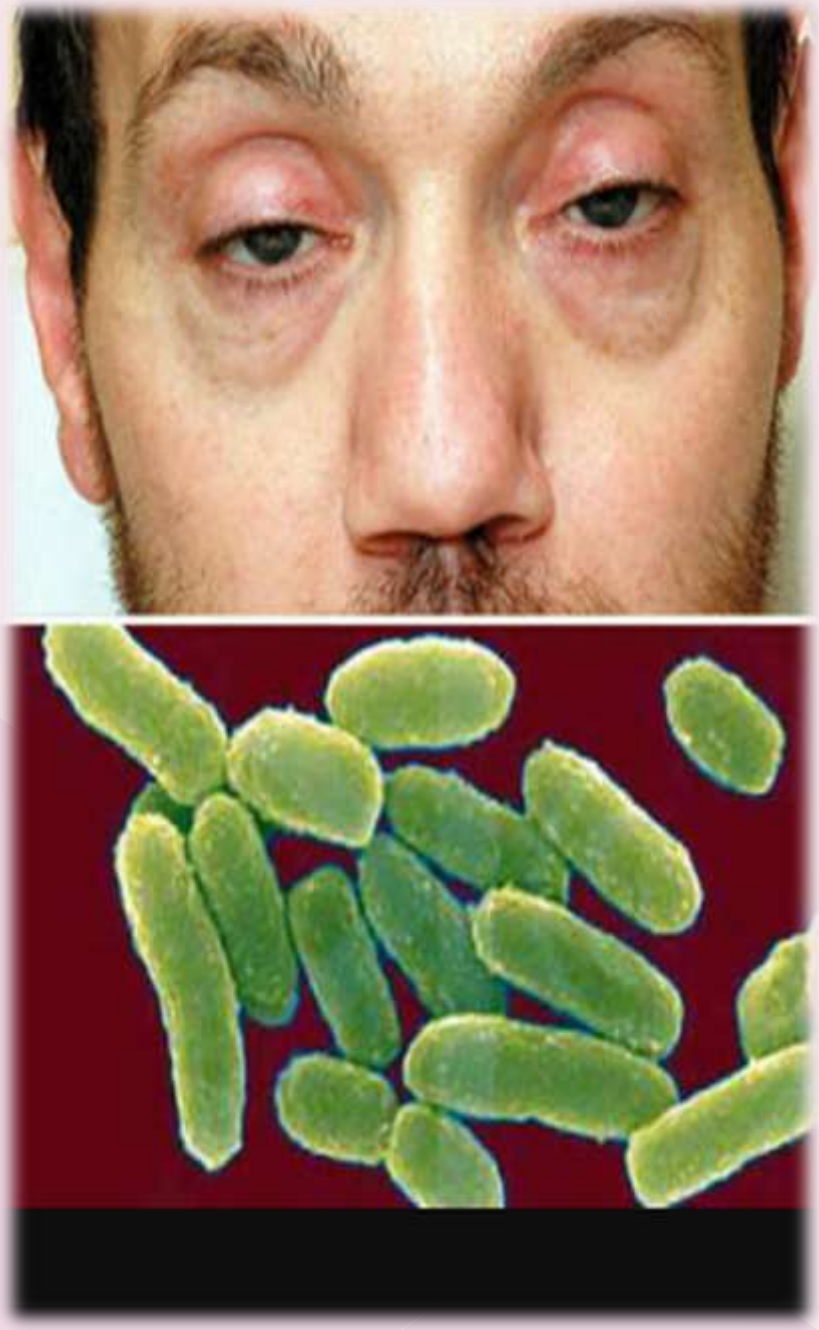

Rust- cans

Canned food and botulism

- The disease is caused by *C.botulinum*
- which is a Gram positive, motile, anaerobic, rod shapped bacteria .
- Low pH (4.6), in the temperature range of 20 to 45.
- Some strains produce botulinal enterotoxins that cause severe neuroparalytic condition known as botulism.
- Eight types of botulinal neurotoxins from A to H
- Human botulism is caused by types A, B, E and rarely F



- The most common way of getting botulism is either by eating the contaminated foods or drinking the contaminated beverages.
- The patient may show blurred or double vision, vertigo, dry mouth, slurred speech, drooping eyelids, difficulty in swallowing and speaking, muscles weakness, marked fatigue and weakness Vomiting, diarrhoea and abdominal pain .
- Unless treated, mortality rate may be very high which may vary from 30 to 65 %
- The death may occur due to respiratory and cardiac failure; and recovery may be slow

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