Spoilage of canned foods
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Introduction

- Canned foods – known as commercially sterile foods
  - Heat in hermetically sealed containers (no gas or microorganism trans passing)
  - No M.O. able to grow and spoil under normal storage conditions
  - No pathogenic M.O.
  - Only heat resistant thermophilic sporformers can remain
Canned Foods

- There are four groups based on pH
  1. Low acid canned foods (pH > 5.2)
     1. Meat products, seafood, milk, certain vegetables, corn and pears
  2. Medium acid canned foods (pH 4.6 - 5.2)
     1. Meat products with vegetable
  3. Acid canned foods (pH 4.0 - 4.6)
     1. Tomatoes, pears, figs, pineapple, olives, cucumbers and other fruits
  4. High acid canned foods (pH < 4.0)
     1. Pickle, grapefruit, citrus juices, peaches, pineapples
Commercial sterility

- Heat treatment depending on the pH of the product
- Sterility conditions is determined by test organisms and pH
  - Low acid foods - foods with pH above 4.6 are heated above 100°C to destroy heat resistant spores of pathogenic bacteria (Clostridium botulinum) - 12 D processes
    - Some spoilage spore forming bacteria have greater heat resistancy than C. botulinum, they can survive at this temperature and can spoil the canned food
      - Bacillus sterotermophilus
      - C. thermosaccharolyticum
Commercial sterility

- Foods with pH 4.0-4.6 heat treated at 100°C
  - Vegetative cells and spores
  - *C. botulinum* cells and spores can easily inactivated by heat at low pH
    - *B. sterotermophilus*
    - *B. coagulans*
Commercial sterility

- Canned foods with pH lower than 4.0 (high acid foods)
  - Higher acids inhibit most of bacteria
  - Only aciduric molds can survive
    - *Byssochlamys fulva*-test m.o.
Canned Food Spoilage

Three main reasons:
1. Inadequate heating,
   - Allowing in survival and growth of mesophilic m.o.
2. Inadequate cooling after heating or high temperature storage
   - Allowing germination and growth of thermophilic sporeformers
3. Leakage in the cans
   - Allowing microbial contamination from outside after heat treatment
Thermophilic Bacteria

1. Flat sour spoilage
2. Thermophilic anaerobic spoilage
3. Thermophilic anaerobic sulfide spoilage
Thermophilic Bacteria
1. Flat sour spoilage

- No gas formation
- No swelling
- Sourcing - acid formation
  - Facultative anaerob B. stearothermophilus and B. coagulans
- Source is usually plant equipment, sugar, starch and soil
- Occur in low acid and acid canned foods
- The can retains normal
  - Can detected only by culture methods
Thermophilic Bacteria

1. Flat sour spoilage

- B. coagulans-
  - Germinate at 43°C and above
  - Grows well between at 30-50°C
  - Homofermentative under anaerobic cond.
  - Heterofermentative under aerobic conditions
- B. stearothermophilus
  - Optimum growth temp. is 55°C
Thermophilic Bacteria

2. Thermophilic Anaerobic Spoilage

- Anaerobic C. thermostaccharolyticum is responsible
  - $\text{H}_2$ and $\text{CO}_2$ gases produced at high temp.
    - Swells the can and causes bursting
  - Seen at medium acid can food products
  - Sour fermentation and butyric or cheesy odor
Thermophilic Bacteria

3. Thermophilic Anerobic Sulfide Spoilage

- No swelling, H$_2$S production and rotten egg odor
- H$_2$S dissolves in the liquid and reacts with iron
  - Iron sulfide precipitation gives black color
- Obligate anaerobes are responsible
  - Disulfotomaculum nigrificans
  - C. bifermentas
  - C. sporogenes
  - They germinate and grow at thermophilic range
- Low acid canned foods (pears, corn, etc.)
- It indicates under processing, slow cooling or hot storage
Mesophilic Sporeforming Bacteria

1. Spoilage by mesophilic Clostridium species

- Can occur underprocessing
- C. buyricum and C. pasteurianum are mostly responsible
  - Ferment sugar to produce volatile acids (buyric acid)
  - Produce $H_2$ and $CO_2$ gases –swelling
- Also C. sporogenes, C. putrefaciens, C. botulinum metabolize proteins
  - Foul smelling compounds $H_2S$, mercaptans, indoles and ammonia
- Pineapple, pears
Mesophilic Sporeforming Bacteria

1. Spoilage by mesophilic *Bacillus* species

- Mesophilic *Bacillus* spore are not heat resistant as well as the thermophiles
- They survive in inadequate heated canned foods (in low acid home –canned foods) at 100°C
- *B. subtilis* and *B. mesentericus* cause spoilage in poorly evacuated cans
  - Seefoods, meats and evaporated milk
- *B. polymyxa* and *B. macerans* cause spoilage in canned peas, asparagus, spinach, peaches and tomatoes
Psychrophilic Sporeforming Bacteria

- Some Clostridium and Bacillus species are psychrophiles
- Able to spoil refrigerated canned foods (meat and dairy products)
- Produce gas, off-flavors and odors
Spoilage by Nonsporforming Bacteria

- M.o. Survive in cans because of mild heat treatment or leak of the can
- Thermoduric nonspore forming bacteria can survive at mild heat treatment
  - Enterococcus, Microbacterium, Streptococcus thermophilus, some species of Micrococcus and Lactobacillus
Spoilage by Nonsporeforming Bacteria

- Acid forming Lactobacillus and Leucocnnostoc spp. Can survive underprocessed tomato products, pears and other fruits
- Heterofermentative – release CO2-swell the can
- Leakage of the can- Psedudomonas, Alcalgenes, Flavonabterium, proteus and other can also cause spoilage
Spoilage by yeast and molds

- Sterilizations kills yeast and molds
- their presences in canned foods indicates under processing, leakage, recontamination and poor evacuation
- Fermentative yeast can spoil canned fruits, jams, jellies, fruit juices, syrups and sweetened condensed milk
  - Swelling the cans by CO2 production
- Film yeast may grow on the surface of pickled meat, pickles, olives and similar products
Spoilage by yeast and molds

- Molds are the most common food spoilage microorganisms in home-canned foods due to high sugar (70%)
  - Jams, jellies, marmalades
  - Penicillium and Citromyces
  - Defects: moldy taste, odor, color fading and presence of mold mycelia
Spoilage by yeast and molds

- Torula lactis and T. globosa cause blowing or gaseous spoilage on sweetened milk (not heat processed)
- Torula stellata causes spoilage in canned lemon and grow at pH 2.5
- Aspergillus repens – buttons on the surface of sweetened condensed milk
Heat resistant Molds

- spoil acidic canned foods, fruits
- most molds and yeasts are killed at 60 to 75°C for a few min.
- heat resistant molds produce ascospores that survive at 85°C for 5 min or 90°C for 1 min
  - byssochlamys (pectin-fermenting), neusartorya, talaromyces and eupenicillum
  - produce mycotoxins