

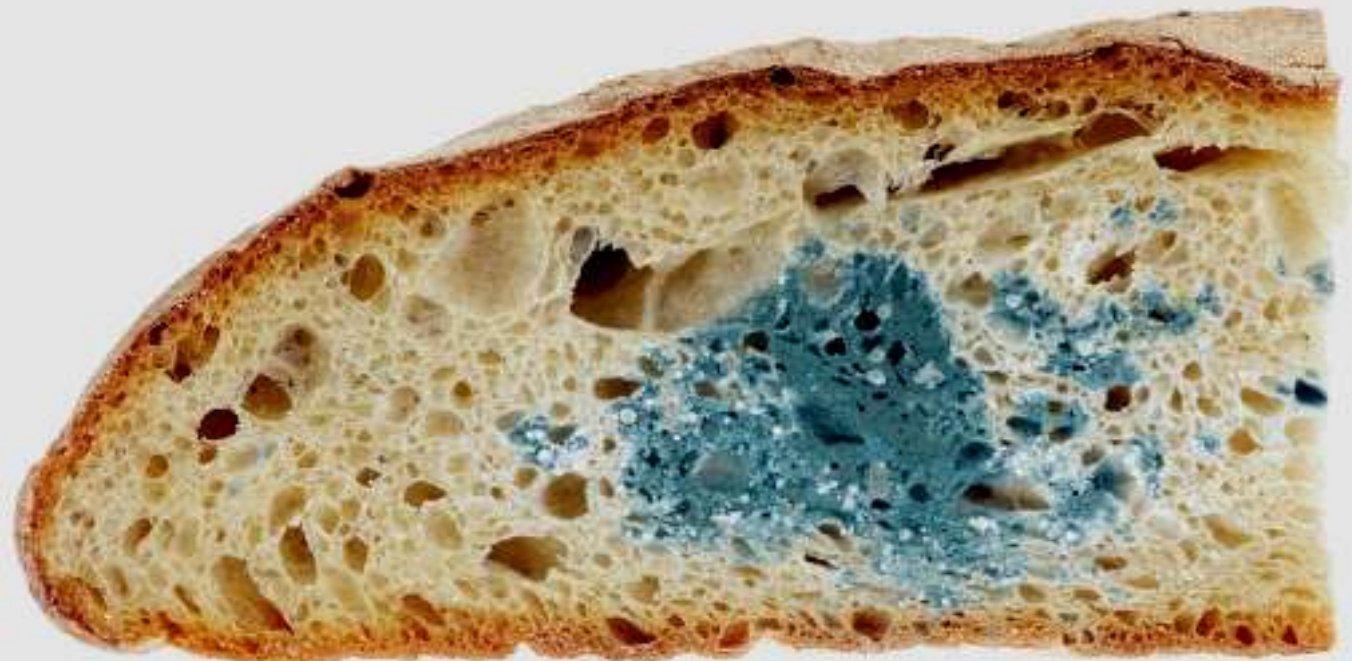


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Microbial spoilage, sources of contamination, control of spoilage of cereals and canned foods





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1. Cereals are important foods which provide bulk of dietary requirements.
2. Source of carbohydrates which are metabolized by body for energy generation.
3. Also provide minerals, proteins and vitamins.
4. India produces a large variety of paddy, wheat, maize, barley millets like jowar, bajra, ragi.
5. Cereal products can be broadly classified into the following groups:
 - **Whole cereals where only the husk of the grain is removed, e.g. rice, wheat, gram, lentils, etc.**
 - **Milled grain products are made by removing the bran and usually the germ of seed and then crushing kernel into various sized pieces eg., wheat flour, maida, semolina (rawa), etc.**
 - **Processed cereals like weaning food, breakfast cereals, etc.**
 - **Ready mixes like cake mix, idli mix, vada mix etc.**



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Grains are low moisture commodities due to which they are less susceptible to spoilage and have greater shelf-life. Spoilage mainly occurs due to moisture absorption during storage leading to fungal growth at high temperature and humidity. Before bulk packaging and storage, whole grains are fumigated to reduce microbial load and increase storage period.

Physical

- **Physical losses are caused by spillages, which occur due to use of faulty packaging materials**

Physiological

- **Physiological losses include respiration and heating in grains, temperature, humidity and oxygen**

Biological

- **Biological losses occurs due to micro-organisms, insects, rodents, etc**



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Sources of Contamination in Cereals





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Cereal Grains and Flours:

1. At initial stages, grains are contaminated by *Pseudomonas*, *Micrococci*, *Lactobacillus*, *Bacillus*.
2. Initial bacterial population may vary from 10^3 - 10^6 per gram while mold population may be $>10^4$ spores per gram.
3. Due to low moisture content, grains and flours usually have long shelf-life if these are properly harvested/stored under proper conditions as microbial growth is not supported.
4. Spoilage of stored grains by molds is attributed to the following factors:
 - ❖ **Type and number of microorganisms**
 - ❖ **Moisture content of more than 12-13%**
 - ❖ **Storage temperature**
 - ❖ **Physical damage**



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5. Common species of molds: *Aspergillus*, *Rhizopus*, *Mucor*, *Fusarium*.
6. Significant aspect of spoilage of molds is production of mycotoxins, which may pose danger to health.
7. Process of flour making such as washing, milling reduce the microbial content.
8. Moisture content of <15% does not allow growth of molds.
9. Most molds and bacteria in flours can grow only above 17% moisture, thus moistening of flours is essential for spoilage.





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Spoilage of Bread

1. Bread is a major product prepared using flours.
2. Dough is prepared from flours which undergo fermentation for which desirable microorganisms must grow.
3. If this fermentation exceeds required limits, it causes souring.
4. Excessive growth of proteolytic bacteria reduces gas holding capacity which is otherwise required for dough rising.
5. Spoilage of bread is usually of two types viz. moldiness and ropiness.
6. During bread making, it is baked at very high temperature, so, less chances of survival of microorganisms.
7. Molds which are prevalent are *Rhizopus stolonifer* (referred as bread mold), *Penicillium expansum*, *Aspergillus niger*, *Mucor* and *Geotrichum* also develop.



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8. Chief causative organism of ropiness in bread is *Bacillus subtilis*/*B. licheniformis* (spore forming bacteria with their spores surviving baking temperatures). These spores can germinate into vegetative cells, once they get suitable conditions as heat treatment activates them.
9. In ropiness, hydrolysis of bread flour protein (gluten) takes place by proteinases.
10. Ropiness is development of yellow to brown color and soft and sticky surface, accompanied by odor.





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Type of Spoilage

Causative Organisms

Ropy Bread (Home made)

Bacillus subtilis

Chalky Bread

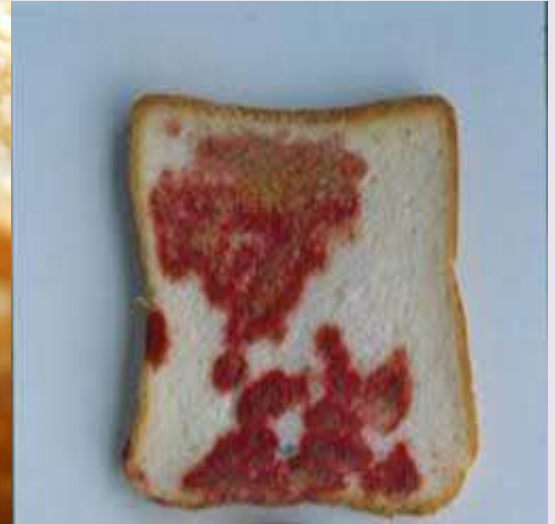
Endomycopsis fibuligera

Red or Bloody bread

Serratia marcescens

Imparting pigmentation

Neurospora and Geotrichum





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Canning is one of important method of packaging food for long term storage.

Normally food is stored in metallic containers along with heat treatment.

Microorganisms may survive if the heat treatment is not proper thereby leading to spoilage of food. Spoilage of can could be due to biological/chemical/comboination of both. Biological spoilage is due to microbial growth while chemical spoilage is due to hydrogen produced due to reaction of acid in food and iron on can. Degree of swelling can also be increased by high summer temperature and high altitudes.





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Causes of Spoilage in Cans

Chemical spoilage:

1. **Due to production of hydrogen gas produced in can because of action of acid of food on iron of can. This spoilage is termed as Hydrogen swell.**
2. **Occurs due to following factors:**

Increased storage temperature

Increased acidity of food

Improper exhaust

Presence of soluble sulfur and phosphorous compounds

Improper timing and lacquering of can at internal surfaces



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Biological spoilage:

- Cause of biological spoilage is microbial activity. In heat treated cans, growth of microorganisms occur due to:

Leakage of can

1. Occurs because of manufacturing defects, punctures or rough handling.
2. Bacteria are introduced into can by either in holes or improper seams.
3. In this type, microorganisms are not usually heat resistant and array of organisms cause spoilage as it is post processing contamination.
4. Microbes may also get entry into can due to cold water, used to cool cans after heat treatment.
5. Leakage may also be responsible for release of vacuum, which can favor growth of microorganisms.

Under processing

1. Sub-optimal heat treatment, faulty retort operations, excessive microbial load and contamination in product, change in consistency of product.



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Stages in Appearance of Can

Appearance of Can	Description
Flat	This is normal stage of can where ends of can are slightly concave. At this stage partial vacuum exist in can. It maintains the condition even if dropped on solid surface.
Flipper	This appears flat but on dropping it on solid surface, either end can become convex. On applying pressure the can regains its shape.
Springer	It has both ends bulged but if pushed inside, one end remain concave but other flips out. This appearance describes slight pressure in the cans usually caused by poor exhaust, overfilling, denting or variation in temperature. Usually no gas production occurs.
Soft swell	The ends are bulged due to presence of gas in can but the ends can be pushed inside with light pressure.
Hard swell	This is stage where high gas pressure accumulates inside can and bulged ends cannot be pushed inside manually. Due to pressure the ends or side seam may buckle or distort. A very high pressure may lead to bursting of can through seam or ends.
Breather	This is a type of can which has minute leak allowing air movement into the can. It may not allow microbial entry into can.

Various stages of spoilage in can



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Microbial Spoilage of Canned Foods

Microbial spoilage of canned food is classified as caused by thermophilic bacteria and mesophilic organisms.

Spoilage by thermophilic spore forming bacteria

- Spoilage by these types of bacteria is most prevalent in under processed heat treated canned foods.
- Spores survive heat treatment and undergo vegetative cell formation and subsequent growth in canned conditions.

Flat sour spoilage

- Caused by souring bacteria.
- In this spoilage, ends of can remain flat during souring.
- Main organisms: *Bacillus*, while it occurs more frequently in low acid foods. It has ability to produce acid without gas formation.



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TA spoilage

- ❑ Caused by thermophilic anaerobe not producing hydrogen sulfide.
- ❑ *C. thermosaccharolyticum* produces acid and gas in foods (sour or cheesy smell).

Sulfur stinker spoilage

- ❑ Occurs in low acid foods and *Desulfotomaculum nigrificans* is involved.
- ❑ Produces hydrogen sulfide which produce typical odour.



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Spoilage by Mesophilic Spore Formers:

Spoilage type	Characteristic
Mesophilic <i>Clostridium</i> type	<ul style="list-style-type: none">• Sugar fermenting species producing butyric acid involved e.g. <i>C. butyricum</i>, <i>C. pasteurinum</i>• Swelling of container due to CO₂ and Hydrogen• Putrefactive species such as <i>C. sporogenes</i>, <i>C. putrefaciens</i>, <i>C. botulinum</i> too play role• Decompose proteins and produce ammonia, indole, H₂S, skatole• Spoilage prevalent in foods processed at 100°C
Mesophilic <i>Bacillus</i> type	<ul style="list-style-type: none">• <i>Bacillus</i> is most involved• Problem more prominent in poorly evacuated cans• Sea foods, meat, evaporated milk most affected• <i>B. polymyxa</i> and <i>B. macerans</i> involved• Entry of organism through leakage of cans



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Spoilage by Non-Spore Formers:

- ❖ Presence of non spore formers in cans indicate post processing contamination.
- ❖ Organisms whose vegetative cells are heat resistant are more readily found.
- ❖ Prominent organisms: *Enterococcus*, *Streptococcus thermophilus*, *Micrococcus*, *Lactobacillus*, *Leuconostoc*
- ❖ Presence of these organisms indicates leakage of container.
- ❖ Cooling water is one of the important source of contamination, thus coliforms also gain entry into the can through leakage.



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Spoilage by Fungi

Type of organism	Indication
Film and Fermentative yeasts	<ul style="list-style-type: none">•Produce carbon dioxide and swelling of cans•Post pasteurization contamination
Molds (<i>Aspergillus</i> and <i>Penicillium</i> are most spoiling organisms)	Heating as well as sealing is not under total aseptic conditions